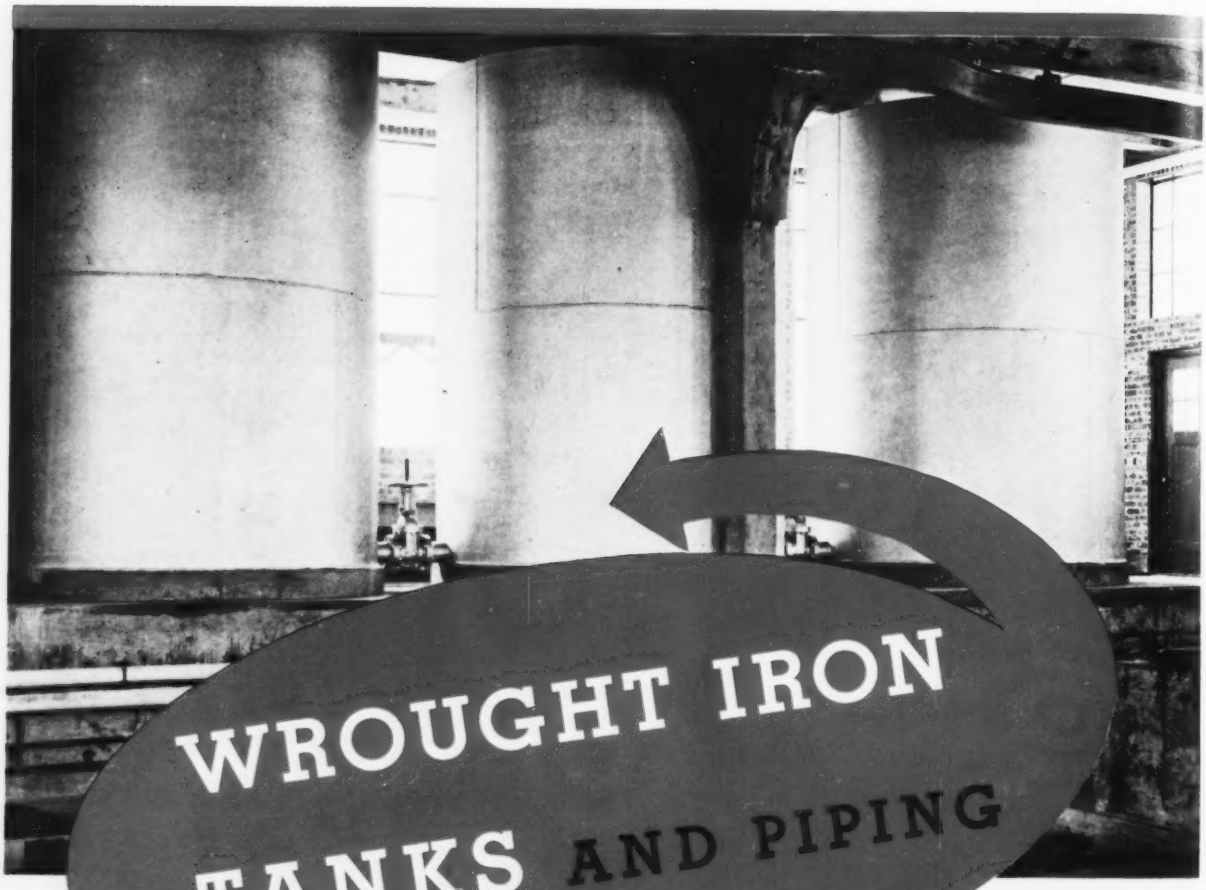
Engineering News-Record

McGraw-Hill Publishing Company, Inc. August 27, 1936 Twenty-five Cents, Five Dollars per Year

GRAND COULEE DAM

Sewage Treatment Corrosion CALLS FOR...



● Here in a sewage treatment plant is a good place to make use of wrought iron's corrosion resistance. The sulphides, nitrates, chlorides—both gaseous and liquid—in sewage make short life of ordinary metals.

However, wrought iron lasts longer and is the choice of leading engineers for many of the services in sewage treatment all over the country. For example, these welded tanks (9′ dia. x 12′ high) are Byers Wrought Iron. They contain a 50% solution of caustic soda and are in the Chlorine Storage Building at the Coney Island Sewage Disposal Plant, Brooklyn.

Wrought iron pipe is also used in the supply and return lines in hot water heating systems in the buildings as well as the rain water leaders. Also the sludge gas lines, oil lines to supply tank and air lines to compressor are wrought iron.

Let this installation guide you in selecting material for corrosive services.

If you wish evidence of wrought iron's long, economical service, your colleagues have recorded it in our files and we'll gladly review it with you. Tell us the type of corrosive service in which you are most interested.

We will also be glad to cooperate with you in making a thorough and accurate study of local corrosive conditions. As a starter in "analyzing local conditions," write our Engineering Service Department in Pittsburgh or our nearest Division Office, mentioning type of project. A. M. Byers Company, Established 1864. Pittsburgh, Boston, New York, Washington, Chicago, St. Louis, Houston.

BYERS GENUINE WROUGHT IRON PRODUCTS

PIPE • WELDING FITTINGS • RIVETS • SPECIAL BENDING PIPE • O.D. TUBES
PLATES • SHEETS • CULVERTS • FORGING BILLETS • STRUCTURALS • BAR IRON

Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

from above, not from beneath

EVERY disastrous visitation of drought gives rise to its quota of fantastic remedies and preventives. The 1936 crop now is accumulating and doubtless the new Congress will have to consider bill after bill designed to advance such schemes. Most of these will die aborning, as they should, but not without having dissipated time and energy that might have been applied more constructively and not without having inflicted on many conscientious legislators some distressing qualms as to whether "there might not be something to" the more plausible schemes.

To many laymen unfortunately, the technical expert is suspect; if his judgment crosses what seems to be "common sense," the average man is tempted to scorn him as one whose practical senses may be dulled by "too much theory." It is this tendency that once drew the delightful and characteristic comment from the late John F. O'Rourke that "common sense, to be truly sense, must be damn well educated." The farther the average man gets from the simple problems of his every day experience, the less likely is his "common sense" to be securely grounded on a basis of fact and substance.

It may be helpful, therefore, for legislators and other non-technical officials who must pass judgment on the drought relief schemes to know that they have at their command a test that should appeal to the "common sense" of the average man as strongly as it does to the trained reason of the qualified expert.

THIS is the principle that no device for supplying water to thirsty land, however plausible and ingenious, can be successful without the water. Coupled with this is the fact that the only known consistent source of that water is the rain or snow that falls from the clouds to the surface of the earth. The immediate source may be a stream formed by that part of the rainfall which runs off the surface, a well that cuts into the accumulated water that has sunk into the soil, an artesian well that taps a stratum carrying water under pressure, or even one of those fabulous "underground rivers" we hear about now and then; but whatever may be the *immediate* source, it is the *ultimate* source that determines the continuity of the supply, and that must be the precipitation of rain and snow on the tributary surface of the earth.

It is true, of course, that the accumulation of past rainfall, either in ponds on the surface or in water-logged strata beneath, provides a certain storage that may be used in addition to current rainfall for a limited time. But as such reservoirs, whether natural or man-made, are drawn below their normal levels they become more and more difficult and costly to use; sooner or later they will run dry unless replenished by new falls of rain or snow. We cannot indefinitely draw on such sources in excess of the precipitation on the surface; the ultimate source of water supply is above us, not beneath us. The average man sees this clearly in the case of man-made surface reservoirs; usually it is with respect to the underground accumulations that he falls a prey to the miracle-men.

This is not written to usurp the function of the qualified technician, retained to advise the public or its officials on some particular scheme or project. Rather is its purpose to bespeak public confidence in their counsel and to remind the non-technical man that if that counsel is disappointingly at odds with the promises of the miracle-men, it probably is because the expert knows that he can extract no more than flows in, that water supply has revealed no perpetual motion unknown to other departments of human enterprise.

DEFENSE against drought involves emergency use of all available storage, never forgetting that such supplies are definitely limited in amount; prevention of drought involves such control and regulation as will insure the most efficient use of the known rainfall and the limitation of our projects for water use to that known supply. Beyond that no man can go. It is futile to count on phantom supplies that can be shown by recorded rainfall data to have no continuous or consistent existence.

Willard Chevalier

ENGINEERING NEWS-RECORD Published every Thursday. Vol. 117, No. 9. Price 25c. per copy. Subscription, domestic, Canada, Mexico, Central and South American countries, $5 per year. All other countries $9 a year or 36 shillings. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U.S.A. Cable Address "McGrawhill, New York." Member A.B.P. Member A.B.C.

Copyright 1936 by McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d St., New York; 520 N. Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W.C. 2, England
Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.
JAMES H. McGRAW, JR., Chairman — MALCOLM MUIR, President — JAMES H. McGRAW, Honorary Chairman
WILLARD CHEVALIER, Vice President — E. R. PUTNAM, Treasurer — D. C. McGRAW, Secretary

Table of Contents—See Page 21

BETTER THAN THE BEST FORGED STEELS YOU HAVE EVER USED

No wonder Timken Bits drill faster and last longer—they are made of Timken Steel produced in the Timken Steel Plant under the same strict system of quality control as the steel for Timken Bearings.

Timken Steel gives Timken Bits—

SHARPNESS to penetrate the hardest rock in record time.

HARDNESS to resist abrasion and wear.

TOUGHNESS to stand up under the terrific pounding of the drills.

These qualities, combined with the elimination of forging expense and a radical reduction in steel investment, make Timken Bits the most economical tools ever known for rock drilling.

If you are not using them you are losing money on every hole you drill. Write for the proof.

Complete Stocks Maintained in Principal Distributing Centers

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN BITS

ENGINEERING NEWS-RECORD

McGraw-Hill Publishing Co., Inc. Editorial and Publishing Offices, 330 West 42d St., New York

Editorial Staff
V. T. Boughton
W. G. Bowman
Chicago
W. W. De Berard

F. E. Schmitt, *Editor*

Willard Chevalier, *Vice-President*

Editorial Staff
C. S. Hill
H. W. Richardson
E. J. Cleary
San Francisco
N. A. Bowers

Volume 117 Number 9 Copyright 1936

August 27, 1936

German Superhighways

General Discussion ..... *John S. Crandell* 289

Construction Details ..... *I. Gutmann* 292

Fort Peck Dam Today—V

Spillway Paving and Structures ..... *H. W. Richardson* 295

Spinning Cables in the Saddles ..... *J. H. Leon* 300

Mosquito Control Engineering—V

Salt-Marsh Mosquitoes ..... *R. J. Vanderwerker* 304

Title Discrepancies Cause Surveying Difficulties *H. P. Coloney* 307

Brick Bleachers for Ohio School ..... *H. C. Plummer* 309

Clean Streams for Wisconsin 310

Current Engineering Literature .. 312

Letters to the Editor 314

Editorials 316

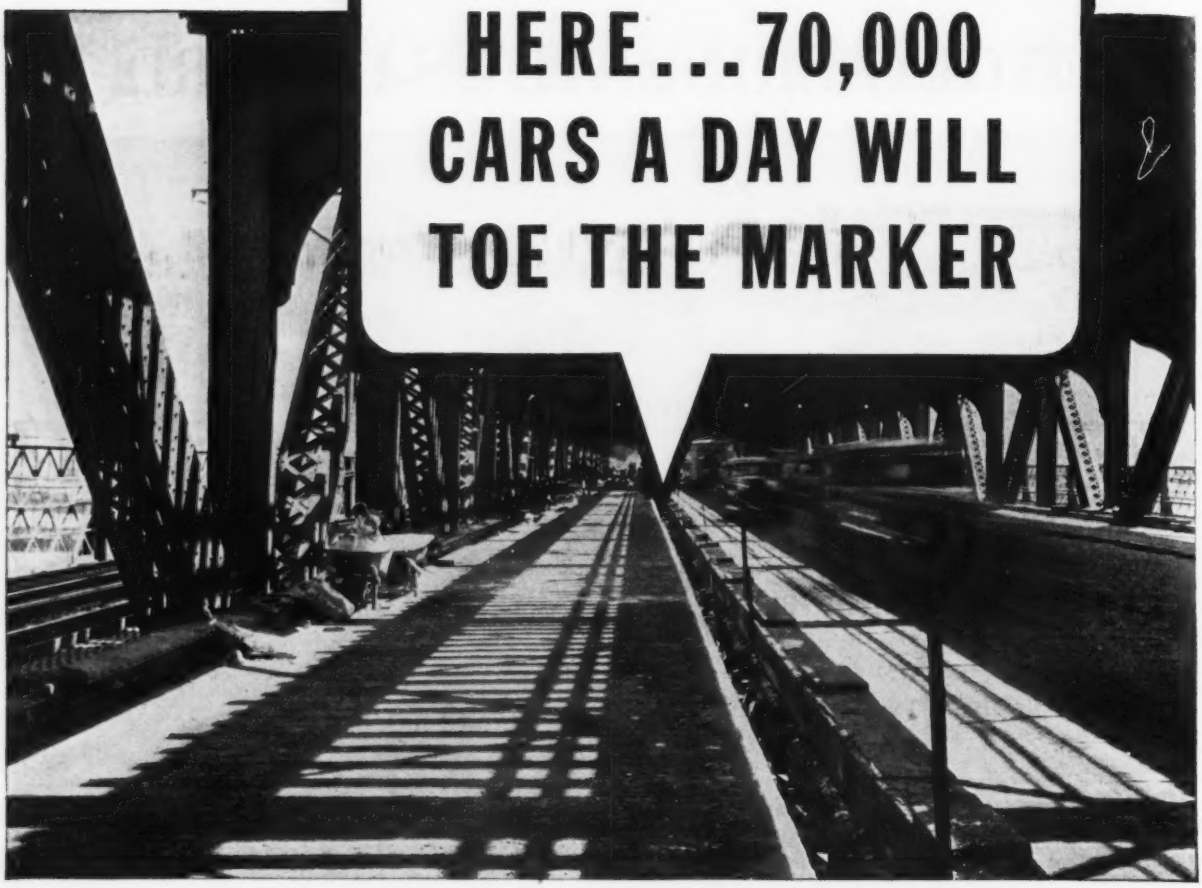
Current News 318

■

Too Great a Temptation—The reader who is led by the cover picture to expect an article on Grand Coulee Dam in this issue is going to be disappointed, for there is no article. The picture came from the Bureau of Reclamation a few days ago. It was so striking that we could not resist the temptation to use it for a cover while it was fresh.

It shows the grooved face of one of the great blocks in which the dam is being built and, in the foreground, men cleaning up for a new pour on the adjoining block.

HERE...70,000 CARS A DAY WILL TOE THE MARKER



Traffic marker of Atlas White Portland Cement being installed on Queensboro Bridge, New York City.
Marker constructed under direction of the Department of Plant and Structures.

SEVENTY thousand in twenty-four hours is a lot of cars for one bridge to handle . . . even a bridge as big as New York's Queensboro. Here, traffic must flow smoothly . . . *must* keep to the right lanes.

To help accomplish this, the city is installing a marker of Atlas White portland cement. A white strip of authority, six inches wide, only one inch deep. Yet this marker is *permanently efficient*, for Atlas White markers of durable portland cement are an actual part of the pavement, and are not to be confused with the temporary type of traffic marker which is merely painted on the surface.

Rain can't wash out Atlas White markers. Sun can't fade them out. They can't wear out. And if you drive over this bridge years from now, you'll find this marker still fresh-looking and white. And not one cent for maintenance will have been paid out on it. Because the first cost is the last. This first cost *is* higher than for temporary methods, naturally. But in the long run it's worth the difference many times over. There is never any replacement expense. You simply install Atlas White markers . . . and forget them.

Help Build Safety into Streets and Highways with Atlas White Traffic Markers • Made with Atlas White Portland Cement • Plain and Waterproofed

UNIVERSAL ATLAS CEMENT CO.

United States Steel Corporation Subsidiary **208 South La Salle Street, Chicago**

M-7

ATLAS WHITE PORTLAND CEMENT FOR TRAFFIC MARKERS

ENGINEERING NEWS-RECORD

August 27, 1936

European Photo Service

FIG. 1—ONE OF THE EXPRESS ROADS made for speeds of 112 miles an hour with which Germany is spanning the nation

Germany Builds Superhighways

5,000-mile system of high-speed paved roads now one-sixth completed is under active construction to elevate Germany to leadership in express roadbuilding

By John S. Crandell

Professor of Highway Engineering, University of Illinois, Urbana, Ill.

ALTHOUGH Italy's 280 miles of superhighways (*ENR*, Nov. 14, 1935, p. 665) were the first to be finished in Europe, Germany is not far behind at the moment, and she will far surpass this record in the near future. Italy is taking a rest from road building; Germany is working hard. Traffic conditions in Italy do not call for the immediate increase in length of the existing motor roads, and Italian labor has been drafted for military purposes. Traffic conditions in Germany are no more intense than those in Italy, but there is unemployment, there are idle plants, and some day, maybe, it will be necessary to move troops rapidly from one frontier to another. Hence, Germany has embarked on a *kolossal* program that contemplates the construction of nearly 5,000 miles of motor superhighways. The accompanying map indicates in general what is contemplated, although there are are other roads that may be added from time to time.

An automobile trip in Germany today immediately impresses the driver with the fact that road building there has lagged behind that of Switzerland, Italy and France, but is far ahead of Austria. There are thousands of kilometers of good old macadam that have been surface-treated with bitumen; there are many kilometers of Durax (Kleinpflaster); there are some short lenghs of concrete, and there is a great mileage of plain, ordinary, old-fashioned roads of various types which are not suited to motor traffic.

Some stretches of the old roads have been given spasmodic bituminous treatments, but the work was so poorly done, and maintenance has been so faulty that they would have been better left untreated. Grades are often very steep and the roadways are narrow and crooked, with deep ditches and no shoulders, fences adjacent to the roadway and poles and trees directly at the edges of the traveled way. Where surface treatments have been given, the surface is often a washboard and full of holes. Dust is the same nuisance it was with us twenty years ago.

The main national roads connecting the large centers are in good condition, for the most part, but they are too narrow, they have too many sharp curves and they are unsuited to carry really heavy traffic. It should be kept in mind that Germany, like Italy, has a preponderance of animal-drawn vehicles. It is no unusual thing to see the highway fairly well crowded with wagons being drawn by either bullocks, milch-cows, horses or by *die hausfrau* and a dog or two. Bicycles and motor cycles are everywhere, being ridden by men, women, boys and girls, and the baby tied on fore or aft. The bicycle habit reminds one of America in the gay nineties.

Motor cars and trucks are in the minority except in the large cities. Indeed, the German could very well say that the highways as they are at present are sufficient unto his needs for some time to come, and he would be right. But the present political regime believes that modernization of the highway system will add materially to the country's financial strength; will stimulate industry by assuring lower transportation

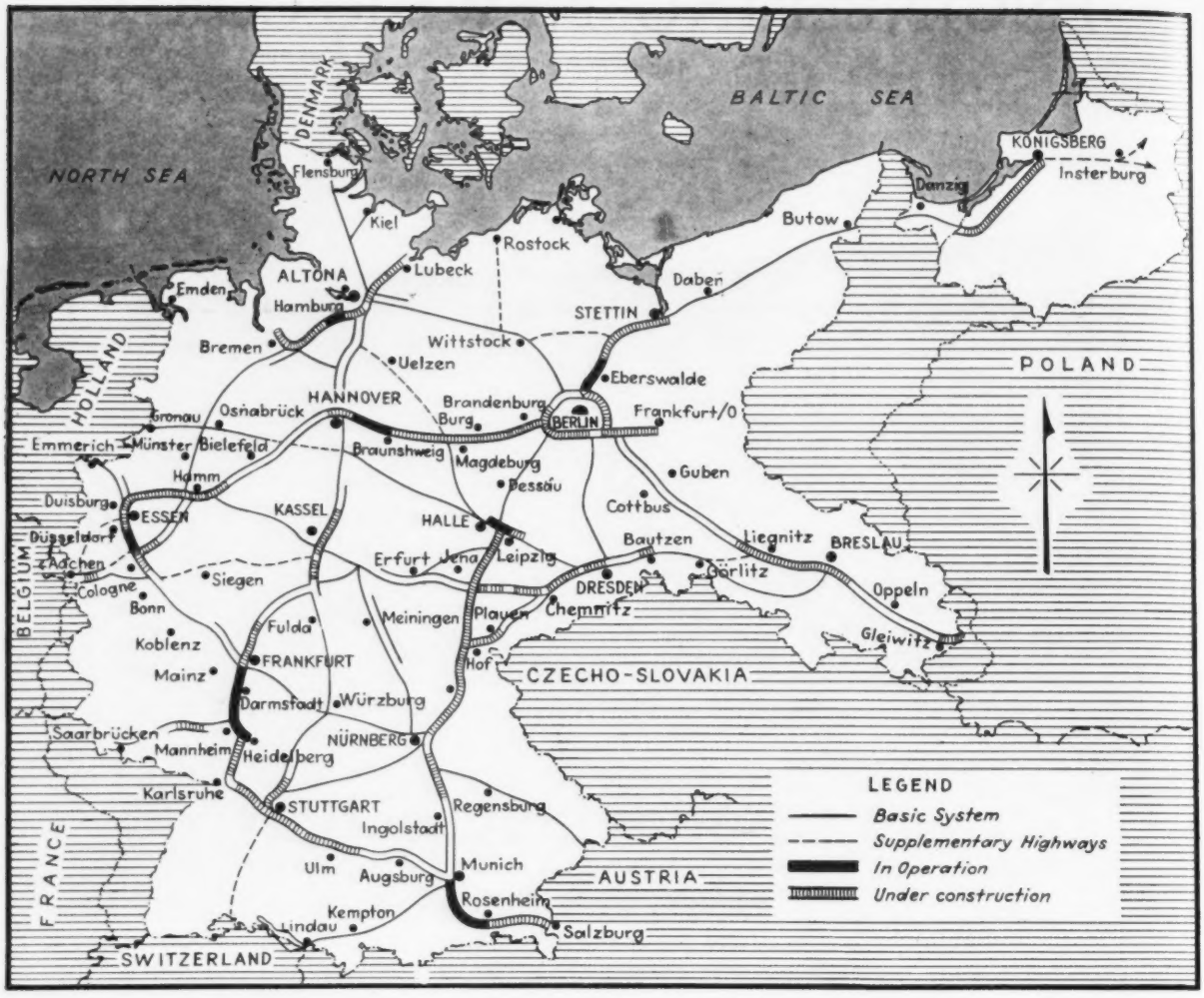


FIG. 2—THE GERMAN EXPRESS HIGHWAY system is the greatest in the world; when completed a four-lane paved road will extend to every border city of magnitude.

costs; will afford an alluring network of routes for the tourists who bring dollars and pounds to the hotel proprietors, and will help materially to take care of present-day labor troubles.

The new motor roads

Toll will not be charged on the German motor roads. At least that is the idea now, although it was said that perhaps in time it may be found advisable to help pay for them in this way. The total cost has been figured at about $800,000,000, and about a half-million workers will profit thereby during the seven years that the work will have lasted. There will be nearly 10,000 bridges built on the 5,000 mi. of highways. It has been estimated that there will be used about 5,000,000 cu.yd. of concrete and a half million tons of steel for bridges and culverts alone.

Work on the motor roads was not begun until Sept. 23, 1933 when Hitler turned the first spadeful of soil. He had announced the program for the future on May 1 of that year. During his imprisonment at Landsberg it is said that he occupied himself with the development of the scheme of building motor roads that would connect all important centers. He saw the wisdom of utilizing in amplified form a plan that had originated in 1926 with a private concern that had studied the possibilities of building a motor road from Hamburg to Basle via Frankfort-am-Main. This would connect with the Italian system north of Milan if the motorist followed the easy and excellent main route through Switzerland. Hitler's original program called for about 3,000 mi. of superhighways (Reichautobahnen), but this was soon increased to 4,500 mi. and still more has been added. The motor road system was placed under the administration and control of the German railroad management and Inspector-General Fred Todt was placed in charge of the work. Hitler opened the Frankfort-Mannheim section to traffic on May 19, 1935. It was this section that was begun in 1933.

The new highway system and the national railroad system are under the same management. This was, perhaps, a shrewd step forward, since it does away with jealousy and managerial warfare. Under the "Generaldirektor" are fifteen chief construction committees among which are officials of the railroad some of whom devote all of their time to the highway work, and others are on part time to both. These committees are established in cities where a director of the railroad system is located. Under the supervision of the chief committees are sub-committees whose work is the building of sections of the highway from 19 to 25 mi. in length.

The chief committee at Munich controls six sub-committees. The Munich section has taken special care to preserve the natural beauties of the landscape. The edict has gone forth that the highways must be made to harmonize with the country side, and to that end the highway engineer has as one of his assistants a well qualified landscape engineer.

The Italian and the German motor roads remind one of the Westchester County Park System, New York. There are no grade crossings with either railroads or highways. Grades are under 5 per cent, in general, although 7 per

cent is occasionally encountered on short stretches. The motor roads connect with the old road system at the outskirts of the towns, and all towns are bypassed. On tangents the crown of the pavement is 1.5 per cent. Curves are superelevated up to 6 per cent.

For the most part the pavement is two-course reinforced concrete. On unsettled fills asphaltic concrete is used. Irrespective of wearing surface a 30-cm (12 in.) telford base is built. On this the two-course concrete pavement is laid 25 cm. thick (10 in.). Or asphaltic concrete 20 cm. thick (8 in.) is laid in two courses. It is thought the 10 in. is too thick for the portland-cement concrete, and it may be reduced to 7½ in. in later work. It was also said that perhaps the telford base is not necessary throughout the system, and that American practcie may be followed of laying the concrete on the compacted earth subgrade.

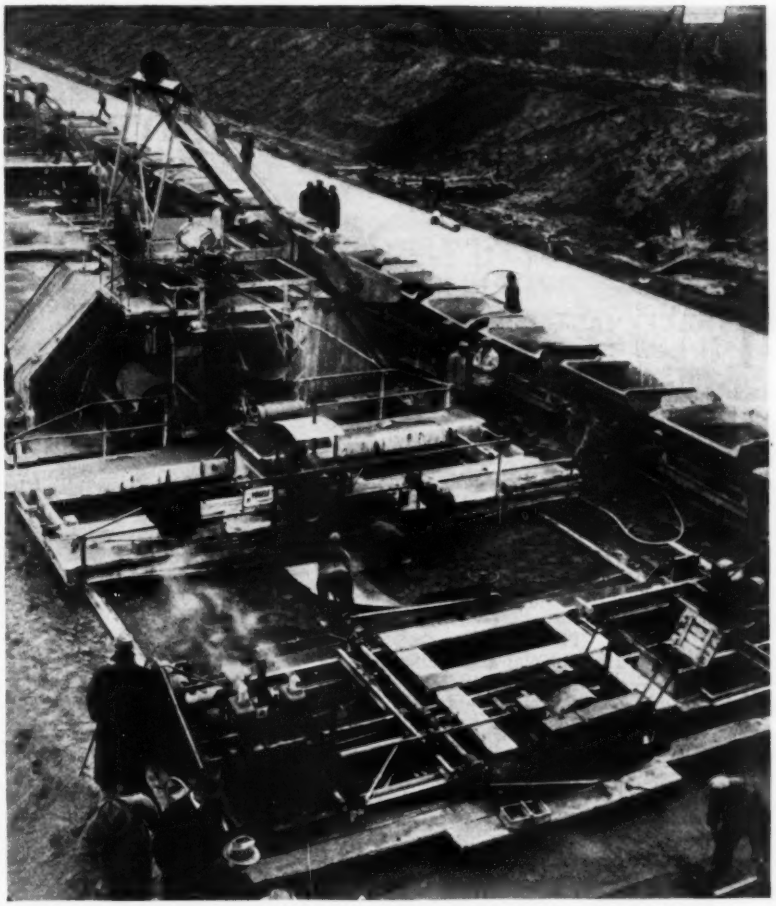
The finished section from Munich to Landesgranze is typical of much of the entire system and the cross-section (Fig. 4) gives the reader a good idea of the vastness of the German scheme. The total width is 78¾ ft. There are two carriageways, each 24.6 ft. wide, and a landscaped center strip 16.4 ft. wide planted with trees and grass. The two shoulders, one on either side of the carriageways, are 6.56 ft. wide, 3.28 ft. of which is paved with bituminous macadam, and the rest is planted to grass. On the stretch from Siegsdorf to Reichenhall the total width is diminished to 56 ft., the slabs are 23 ft. wide and the middle strip is reduced to serve solely as a marking strip about 1 ft. wide.

Since traffic travels in one direction only on each carriageway there can be no head-on collisions, and the middle planted strip assures the driver of freedom from headlight glare. There is ample width for three lanes of traffic in each direction. The bituminous macadam shoulder is 3.28 ft. wide; it is at the outer edge of each carriageway, and immediately adjacent to the fence, beyond which is a ditch which may be, and usually is, 3.28 ft. deep. Trees and telephone poles are on the fence line. It seems strange that care should not have been taken to make these super highways safe for high speed traffic by having wide shoulders, shallow ditches and trees far enough from the traveled way to constitute no hazard.

Transverse joints are introduced about 33 ft. apart in the concrete pavements, and the slabs are 8 to 12 ft. wide, or thereabouts. There is some variation from this, and some wide slabs were seen. On some sections the transverse joints were staggered about 12 in. with the idea of preventing corner breaks. This has not been satisfactory, and it was said that in the future the joints will extend directly across the pavement from slab to slab. It is interesting here to compare the German scheme of staggered joints with the English scheme of making joints inclined 80 deg. to the curb. In both cases the idea is alike, namely, that by preventing two wheels of a heavily laden truck from striking the joint at the same instant there will fewer cracks develop from impact. It is further interesting to be apprised that both schemes are now discarded, and American practice is being followed.

The new route is astounding. The enormous fills, deep rock cuts, cliffside developments, stream diversion, huge retaining walls and massive bridges, are at variance with the usual work of a highway engineer. The pavement will be 29½ ft. wide. The new road follows in general the line of the existing highway, but curves will be eliminated and grades reduced as much as possible. Yet, of necessity there must be heavy grades in some areas. At one point a grade of 9 per cent was seen, and the connection to the existing road was 16 per cent. The entire road lies close to the Austrian border.

(The following article will describe the engineering standards and methods of constructing the German express roads.)



European Photo Service

FIG. 3—MACHINE PROCESSES are supreme in laying pavement for the new express highways of Germany; the view shows a concrete mixer feeding a spreader followed by a compacting and finishing machine, all traveling astride the pavement on rails.

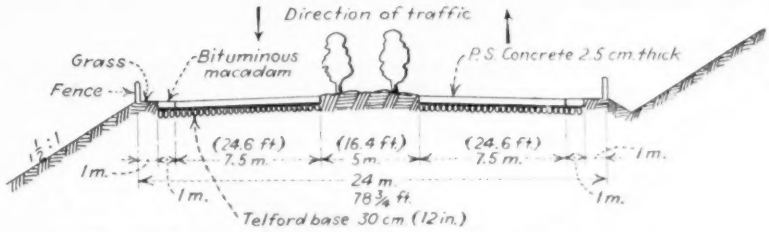


FIG. 3—THE PAVEMENT of the German express roads is among the heaviest pavement structures ever constructed—10 in. of reinforced concrete on 12 in. of telford base.

Engineering Sets High Mark On German Superhighways

By I. Gutmann
Associate Editor, Engineering Index
New York, N. Y.

THE GERMAN GOVERNMENT is building 5,000 miles of four-lane and six-lane concrete express roads designed for a speed of 112 miles per hour (180 km. per hr.) This means that a few years hence Germany will have several mighty traffic arteries running its entire length and breadth, and cars will be able to speed from the eastern border of the Reich to its western frontier in less than seven hours. No country has ever had such a system of highways and the engineering design and methods of construction have exceptional interest. They are described here as derived from official and unofficial German reports and from descriptions by French, Belgian and Polish engineers in professional papers and articles.

Design of curves and grades

The design of alignment and grade is governed by the sight distance necessary for safe driving, which is a function of the stopping distance, which in its turn is a function of the speed of the car, the friction coefficient and the grade of the road. For computation of sight distance where V is speed of car in kilometers per hour, f is coefficient of friction, and α is grade angle, the Germans use the following formula:

Sight distance, in meters $= L =$

$$\frac{V^2}{254} \times \frac{1}{f \pm \tan \alpha} + \frac{V}{3.6} = 0.00394 \frac{V^2}{f \pm \tan \alpha} + 0.278\, V.$$

In mile-and-foot units where V_1 is speed of car in miles per hour, this formula becomes:

Sight distance in feet $= L = 0.0327 \frac{V^2}{f \pm \tan \alpha} + 1.47\, V_1$.

The second term of these formulas ($0.278\, V$ or $1.47\, V_1$) represents the distance traveled by the car during the reaction time assumed to equal 1 sec. The friction coefficient is assumed as $f = 0.5$ and $f = 0.4$. For a speed of 180 km. per hour (nearly 112 mi. per hr.) the required sight distances, in feet, will be as follows:

Grade	Sight distance in feet Friction Coefficient $f = 0.5$	$f = 0.4$
No grade	1,002	1,211
3 per cent up-grade	951	1,138
3 per cent down-grade	1,056	1,295

These are standard sight distances adopted for flat country. For irregular topography this standard would be entirely prohibitive in cost, and a maximum sight distance of 656 ft. (200 m.) had to be set arbitrarily, corresponding to a speed of about 87 mi. per hr.

In computing sight distance along curves and at summits a standard car is assumed, 4.9 ft. high, with the eye of the driver 3.9 ft. above the ground and 4.3 ft. from the vertical plane of the two right wheels of the car. Two kinds of obstacles are considered: (1) A standard car and (2) an object near the summit projecting 20 cm. (about 8 in.) from the ground surface upwards. The critical condition occurs in the case of a curve in cut and concave towards the sidehill. Computations have shown that in this case a sight distance of 984 ft., which is proper, under average conditions, for a speed of about 110 mi. per hr., will require a radius of curvature of over 6,560 ft. or about a 52-min. curve. Similarly, for a sight distance of 656 ft. corresponding to a permissible speed of about 87 mi. per hr., the required radius of curvature will be about 3,300 ft., equivalent to a 1 deg. 44 min. curve. A similar analysis for vertical curves shows that for a speed of about 111 mi. per hr., the radius of vertical curvature would have to be not less than 54,700 ft., equivalent roughly to a 6-min. curve.

With these considerations in mind the Reichsautobahnen are grouped in three classes, according to topography.

1. *Roads in level country* with horizontal curves having radii greater than 6,560 ft., convex vertical curves with radii greater than 54,700 ft. (about 6 min.) and concave vertical curves with radii greater than 16,400 ft. As a matter of fact many horizontal curves of this class of roads have radii of curvature up to about 16,000 ft. in length (21 min.) and superelevation requirements result in a transverse grade of 1½ to 4 per cent.

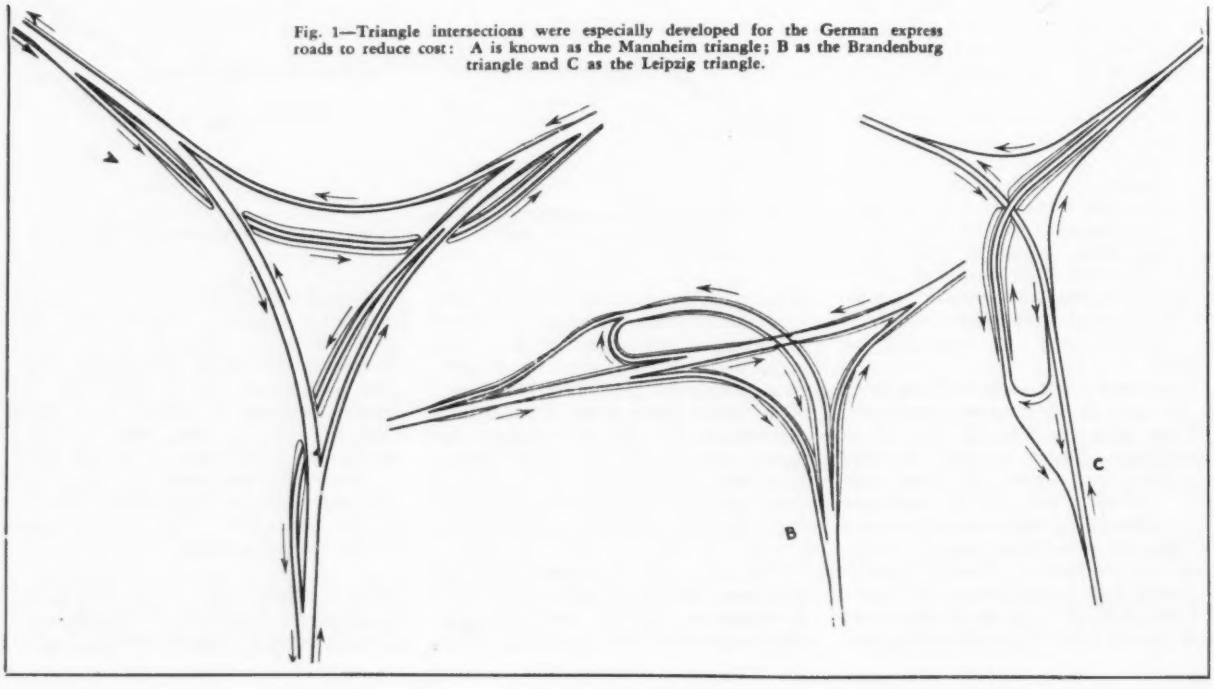


Fig. 1—Triangle intersections were especially developed for the German express roads to reduce cost: A is known as the Mannheim triangle; B as the Brandenburg triangle and C as the Leipzig triangle.

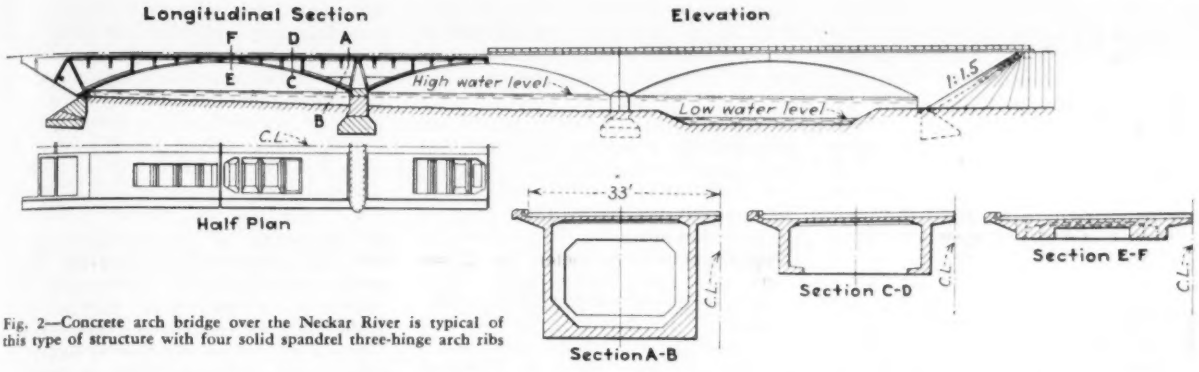


Fig. 2—Concrete arch bridge over the Neckar River is typical of this type of structure with four solid spandrel three-hinge arch ribs

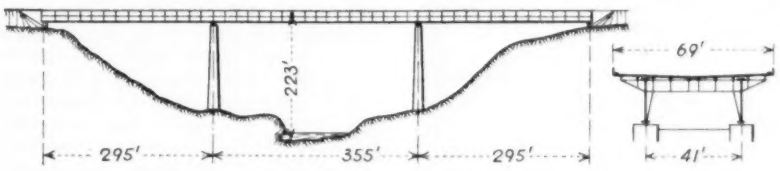


Fig. 3—Mangfall viaduct is typical of the steel bridges which are usually continuous plate girders on tall piers of concrete or steel

2. *Roads in country of irregular topography* with horizontal curves having radii greater than 3,300 ft. (1 deg. 44 min.) convex vertical curves with radii exceeding 32,800 ft. (about 11 min.) and concave vertical curves with radii from 9,800 ft. to 16,400 ft. in length (35 to 21 min.)

3. *Roads in mountainous country* where horizontal curves may have radii only about 1,300 ft. long (4 deg. 22 min.)

Grades are generally not over 2 per cent on roads of the first class, up to 5 or 7 per cent on roads of the second class, and may be considerably steeper than this on roads of the third class.

The Germans did not adopt our cloverleaf type of intersection; it is too costly, though they admit it to be the only perfect solution of the intersection problem for expressways. Instead, they adopted some semi-cloverleaf designs and have also developed original intersection layouts exemplified by the so-called "triangles" shown on Fig. 1, some of which are reminiscent of railroad practice.

Bridges and viaducts

In general, in the design of all bridges, viaducts and short grade separation structures, esthetic considerations tending to harmonize and merge the appearance of the structures with the natural landscape and the immediate surroundings have been given extraordinary care. Nowadays, with the fear of invasion and aerial attacks hanging over all of Europe, such careful esthetic treatment of highway structures may assume the utilitarian importance of camouflage.

In constructing the plate girder viaduct over Passarge River at Braunsberg, East Prussia, consisting of eight spans totaling 902 ft., the individual spans were assembled at one of the abutments and launched on rollers to their proper position over the piers. The longest of the spans, 148 ft., weighing 198 tons, was erected in the same way. The span was supported by a system of 8-ply cables and a telescoping erecting tower; its installation took only one hour.

This viaduct as well as the shorter viaducts of the Prussian division of the Reichsautobahnen have been constructed along standard designs characterized by slender bents of reinforced concrete or steel and open deck spans which according to a German writer, "mar the charm of the landscape but little, and with taut horizontal lines bring out the rhythm of the speeding traffic." All of the longer viaducts of this section have roadways only 24.6 ft. wide, corresponding to two-traffic lanes. Later a parallel viaduct of identical design will be built next to each one of these and will be joined with the first, thus producing a roadway 59 ft. wide, corresponding to 4-traffic lanes plus a middle strip nearly 10 ft. wide. There will also be two sidewalks, each 2.5 ft. wide.

The same principles of design are exhibited in three of the largest bridges completed on the highway leading from Munich to the Austrian border. The bridges over the Mangfall (Fig. 3) and over the Prien, as well as the viaduct over the Bergen valley are all characterized by slender reinforced concrete piers and continuous plate girders for the deck spans.

The Mangfall bridge (Fig. 3), 925 ft. long, consists of three spans, of 295 ft., 355 ft. and 295 ft.; the maximum height above the river bottom is 223 ft. The steel superstructure consists principally of two plate girders 18 ft. deep. The roadway, including sidewalks, is 69 ft. wide. The Prien bridge, 551 ft. in length, consists of four spans ranging from 118 ft. to 157.5 ft.; the maximum height above the river bottom is 59 ft. The superstructure consists principally of four continuous plate girders 8.2 ft. deep: the roadway is also 69 ft. wide, The deck of the viaduct spanning the Bergen valley is on a grade of 3.5 per cent. Its total length is 1,132 ft., divided into six spans ranging from 164 ft. to 213 ft.; the maximum hight above valley bottom is 136 ft. It is carried on four continuous plate girders nearly 10 ft. deep; it also has the standard width of 69 ft.

Fine examples of multi-arch concrete bridges will be found west of Munich between Mannheim and Ulm. There is the concrete arch bridge over the Neckar River near Ulm (Fig. 2) consisting of three spans ranging from 166 to 169 ft. The roadway which is about 62 ft. wide is carried on four parallel three-hinge arches with solid spandrels. The Neckar River and canal are again bridged further downstream, near Mannheim, by a six-span concrete arch deck bridge totaling 1,283 ft. in length, with a maximum clear span 226 ft. long. The arches are three-hinged and have solid spandrels. The width of the roadway is 66 ft. The arches are comparatively flat having a maximum rise of about 23 ft. over a clear span of 213 ft. (maximum clear span of longest arch is 226 ft.)

Construction equipment and methods

Speed of construction is the ruling consideration in carrying out the Reichsautobahnen program; probably no German highway job of the past has been as thoroughly mechanized. The machinery industry of Germany has thereby been greatly stimulated and many new machines for road construction have been developed. A few of the more interesting of these will be described here.

Grading—Narrow gage locomotives with compressionless diesel engines have been extensively used for hauling excavated materials, concrete and concrete aggregates. There are six models of these locomotives, three of them de-

signed for a gage of 2 ft. and three for a gage of 3 ft. Their capacities vary from 10 hp. to 45 hp., and their weight from 2.8 tons to 10.5 tons. They are designed for two speeds, of 2.5 miles per hour and 7.5 miles per hour. However, on 3-ft. tracks steam locomotives ranging in power from 180 hp. to 200 hp. have been used predominantly. Dump cars for manual loading range in capacity from 1 to 2 cu.yd.; automatic dump cars, for 3-ft. gage, generally have a capacity of 7 cu.yd.

A great many light, convertible power shovels, ranging in capacity from about ½ cu.yd. to 1½ cu.yd., have been used for compacting road fills; a steel plate, 4,400 lb. to 5,500 lb. in weight, attached to the boom of the shovel is allowed to drop from a height of 5 ft. to 6.5 ft. By this procedure 240 sq.yd. of road surface can be compacted in one hour. Another German product, the "frog" gasoline tamper, has also been widely used for compacting fills. A half-ton model of this device was used in this country in compacting the earth fill of San Gabriel Dam No. 1 (See *Engineering News-Record*, May 14, 1936, p. 700). Now the Germans have a heavier model of the same device weighing 2,200 lb.

For faster work there is also available a so-called earth tamping machine (*ENR*, July 7, p. 115). This machine carries at its rear end a battery of four hammers, weighing 3,300 lb. each, which can be adjusted to drop a maximum height of 4 ft., striking 20 blows per minute each, or a total of 80 blows per minute, and compacting an area of about 600 to 700 sq.yd. per hour. There is also the so-called vibrating tamper that strikes 1,500 blows per minute. The weight of the machine which is 33 tons, adds to the effect of this tamper.

Concrete Paving—Two types of concrete mixers are used: The American drum-gravity mixer and the now old-fashioned positive-action trough mixer with paddles on two axles rotating in opposite directions. The latter type is used particularly in mixing rich concrete. The concrete mixer and its appurtenances are generally set on a platform, traveling on rails, and spanning the entire roadway whose standard width is 24.6 ft. The concrete is discharged from the mixer onto a so called concrete distributor or placer which is a separate unit consisting of a platform traveling on rails, also spanning the entire width of the roadway, and a hopper, generally 1¼ cu.yd. in capacity, traveling on a transverse rail track forming part of the platform.

After the bottom course of concrete has been placed, it is tamped and vibrated with special machines. The finisher tamps the concrete either with a plank or with a set of hammers. These finishers which may be 8 to 30 ft. long are designed to work on both straight and curved stretches. They are mounted on a four-wheel truck traveling on rails laid at the edges of the roadway. They are driven by gasoline or diesel engines, 5 to 12 hp. in capacity, which act on all four wheels. Their speed is about 7.5 ft. per minute forward, and 5½ to 6 ft. per minute in reverse. They generally carry a vertically adjustable screed and a tamping bar or a set of free-drop hammers, each weighing from 110 to 130 lb. and producing 70 blows per minute. Most recent models of these finishers carry also a vibrating drag, oscillating 800 times per minute.

An entirely new type of finisher is the electrically driven eccentric-compressor-finisher. This machine is provided with a horizontally oscillating screed and a cylindrical 2¼-ton roller on eccentric bearings. It delivers 320 blows per minute and moves forward with a speed of about 40 ft. per minute. The machine spans the entire width of the roadway.

Besides these heavy tamping machines, light compressed air tampers are often used. A common type is a compressed air tamper weighing about 76 lb., and striking 1,700 blows per minute. There are also in use several types of concrete vibrators producing from 1,500 to 3,000 vibrations per minute. Extensive research is in progress to establish the economy of vibrating concrete pavements.

Elaborate research under the guidance of Professor Graf, which involved the construction of an experimental road 1¼ mi. long is being carried on. The principal aim of this field and laboratory research is to develop a process for placing both the bottom course and the top course of the concrete pavement in one operation. Great economies are expected to result from these researches.

Joints — Dummy joints penetrating only to the bottom course and through joints penetrating as far as the telford base, are laid both longitudinally and transversely to the roadway. They are of the sandwich type and used to be only from ⅛ to ½ in. wide, but experience showed that transverse joints should be at least from 0.6 in. to 0.8 in. wide, for otherwise when temperatures dropped, the filler would not flow back into the joint but remain protruding two or three centimeters above the slabs. Joints formed by inserting metal plates have been used rather sparingly, only in a longitudinal direction. The metal is inserted into the freshly poured concrete without any additional support, or it is set out before the concrete is poured in which case it is supported with round steel pegs.

The joints are made either by a manual process, or they are cut with special machinery, either while the concrete is still green or after it has completely hardened. Several types of joint-cutting machines are in use. One of these machines is provided with a vibrating knife blade about 6 ft. long cutting through the green concrete down to the telford base; another is provided with an eccentric circular disk penetrating through the entire thickness of the slab. This disk is set on a roller which simultaneously refinishes the slab surface as it is disturbed by the cutting. Larger pieces of rock aggregate have to be removed by hand. Finally there is a machine provided with a rotating carborundum disk cutting through the completely hardened concrete slab. So far this machine has been used only for making longitudinal and transverse dummy joints. It produces sharp straight edges and exact intersections, but, on the other hand the carborundum wears off in the process of cutting and the width of the joint keeps on decreasing, if the cutting disk is not frequently changed. This makes the process rather expensive, furthermore it cannot be used for sharp curves on account of the brittleness of carborundum.

Curing—The specifications require that as soon as the concrete slab is poured and finished it shall be immediately protected from sunshine or rain, as the case may be, by means of movable roofing decks supported a short distance above the slab, which with the addition of side screens completely enclose the fresh concrete surface. Five to six hours after concrete placing, in hot weather, and 7 to 8 hours in cool weather, the roofing decks are removed and the set concrete is covered with moist loam, or with hay to be cured for a duration of 3 to 4 weeks. These roofing decks constructed of steel and wood, are 8 ft. to 16 ft. long and travel on the same rails laid at the edges of the roadway on which the machines move.

To insure a perfectly smooth surface, which is so essential for a highway designed for such high speeds it is necessary to protect the fresh concrete surface from the roughening effect of raindrops. Concrete mixers, pavers, finishers and joint cutting machines have been made to trail rainproof roof decks behind them. It is possible that in time all fresh concrete surfaces will be sheltered from the elements by suitable roof protection.

Progress of construction

Construction seems to be behind the original schedule. On Sept. 20, 1934, General Inspector Fred Todt, announced that 930 mi. had already been contracted for, that 745 mi. would soon reach the construction state, and that the 1,675 mi. of highway would be completed by the end of 1936. Now it is announced that only about 620 mi. will be completed in the fall of 1936. At the end of April, 1936, 138 mi. were in operation and 1,188 mi. under construction.

Nearly 111,000 men and women were employed by the Reichsautobahnen in April, 1936. By that time the total man-hours expended on the entire project was nearly 44,200,000. Excavation and earthwork totaled about 116,400,000 cu.m., steel construction a little over 90,000 tons, concrete and reinforced concrete 2,307,000 cu.m., concrete pavements 7,800,000 sq.m., bituminous and other pavements about 565,000 sq.m.

FORT PECK DAM TODAY—V

Spillway Gates and Channel Paving

H. W. Richardson
Associate Editor, Engineering News-Record

IN OPERATIONS as unique as they are large, one contractor is closing off the upper end of the Fort Peck Dam spillway channel with a complicated control gate structure, while another is spreading 250,000 cu. yd. of concrete over a one-mile length of spillway channel floor and sidewalls. Last year the huge spillway, which cuts for two miles through the hills and coulees of the right bank of the river, was the scene of a rush of dirt-moving activity, with 125 truck units carrying away the shale dug out by 13 shovels at the rate of a million yards a month. This year, though the last million yards of excavation is being removed, concrete activity far overshadows the dirt work.

Shale saws, a new construction tool borrowed from the coal-mining field, rip key slots in sloping banks for wall anchors and carve out V-shaped trenches in the channel floor for a 31-mile network of tile underdrains. An odd-looking 5-ft. diameter auger, dangling from the end of a long crane boom, is completing the last of 467 holes drilled 30 to 40 ft. deep for the supporting piers of the gate structure. Two splendidly equipped central mixing plants turn out concrete night and day, steadily filling forms for the more than one half million cubic yards that go into the structures. Shuttling back and forth from plant to forms, a fleet of bucket-laden trucks feed concrete to specially-rigged cranes and derricks. Excavation, tile laying, steel and form-building crews are humping to keep ahead of the ever-crowding concrete gang.

The spillway

Designed to pass a flow of 255,000 sec.-ft., the spillway lies in a natural valley three miles east of the main dam. It is 9,700 ft. long, has a maximum depth of cut of 145 ft., and varies in bottom width from 800 ft. at the inlet approach to 130 ft. at the narrowest section. The approach channel, 1,900 ft. long, is level, but the discharge channel descends at an average grade of 5.23 per cent, imparting a maximum velocity of about 96 ft. per second to the waste waters.

At the upper end of the spillway is the gate control structure, set between paved channel walls immediately below a short paved approach section. The structure, founded on a 12-ft. thick heavily reinforced concrete slab carried on 467 concrete cylinders 5 ft. in diameter, sunk deep in the shale, consists of steel and concrete piers supporting sixteen 40x25-ft. stoney gates, set in a curved line. The piers extend 187 ft. downstream from the gates as training walls. A craneway, railroad and highway will be carried over the structure.

The floor and lower sidewalls of the discharge channel are being paved with reinforced concrete for a length of 4,761 ft. below the gates. Floor slabs are, in general, 20x40 ft. in plan, 28 in. thick, and are tied together with dowels and a welded 12x5/16-in. steel sealing strip at all construction joints. Underneath the floor slab, also under the sloping walls, is a network of drain tile, aggregating 31 miles in length (Fig. 9). The backbone of the system is a 24-in. line down the center of channel, laid in a deep trench. Deep transverse lines 120 ft. apart form the principal feeders, and there are 6-in. lines under every transverse construction joint. All tile lines, other than that in the main center line, are in V-shaped trenches cut into the shale. The pipe, a vitrified tile with unsealed joints, is laid in a bed of gravel backfill. Concrete collars fill the trenches from top of gravel to bottom of slab.

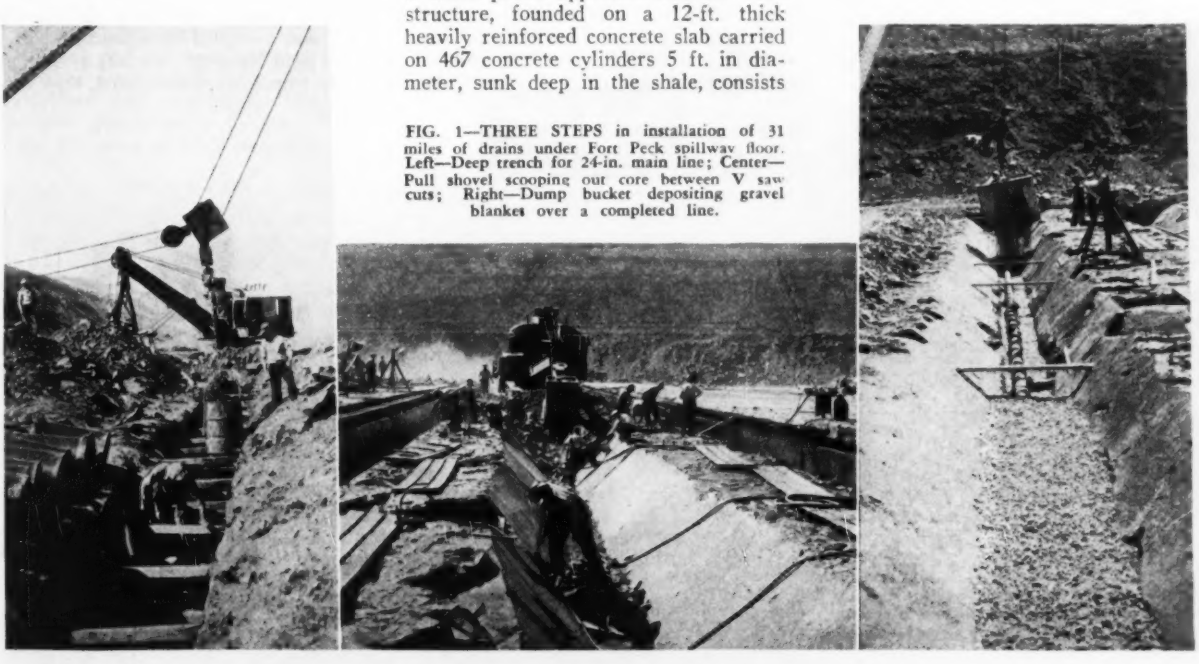


FIG. 1—THREE STEPS in installation of 31 miles of drains under Fort Peck spillway floor. Left—Deep trench for 24-in. main line; Center—Pull shovel scooping out core between V saw cuts; Right—Dump bucket depositing gravel blanket over a completed line.

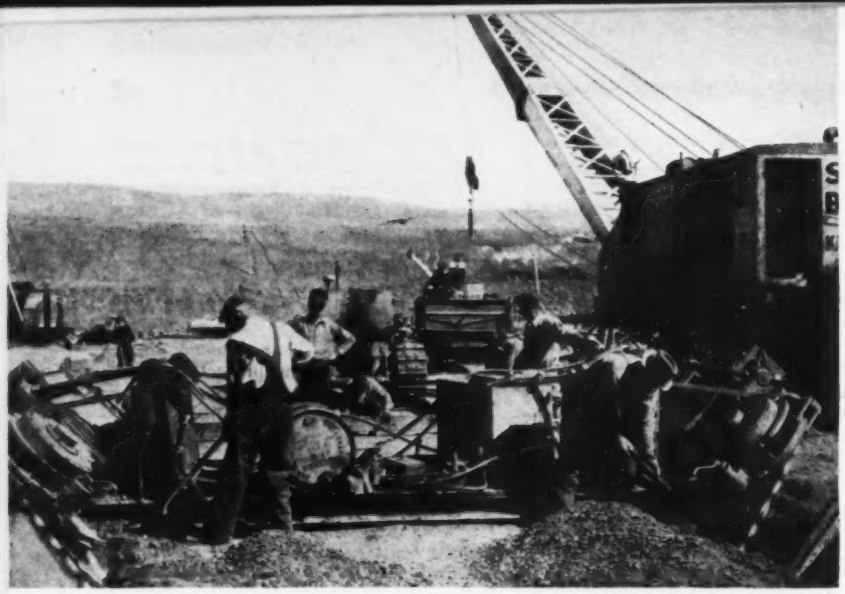


FIG. 2—TWIN SHALE SAWS mounted back to back cut the outlines for miles of V-shaped trenches for the spillway floor subdrains. The saws are adjustable to any angle of cut.

At the lower end of the paved channel is a cellular concrete cut-off wall sunk 130 ft. deep into the shale to prevent underscour. Construction of this structure is just starting.

A more detailed description of the spillway design and structure, and excavation operations of last year, was given in *ENR*, Aug. 29, 1935, p. 283, 301 and 303. The use of shale saws and special augers for boring the foundation holes of the gate structure was described in *ENR*, Jan. 9, 1936, p. 37.

The bulk of the control structure work—excavation, concrete and steel—lies along the curved line of the gates. In this area, under the gate piers, are the 467 deep 5-ft. holes for concrete foundation cylinders, a concrete toe wall 10 ft. wide and 30 ft. deep, and a very heavily reinforced foundation mat, 12 ft. thick and 75 ft. wide, capping the toe wall and the cylinders. A great amount of shale excavation was necessary for these foundations in addition to the stripping of an 8 ft. blanket of shale left by the spillway cut excavators as a protecting cover. The gate supports involve considerable structural steel, erected to unusually close tolerances.

To attack this concentration of heavy operations in the wide mouth of the spillway entrance, the contractor set up a heavy steel traveling stiffleg derrick, steam operated, with a 120-ft. boom that covers the entire reach of foundations. The rig is mounted immediately upstream from the gate foundations on wide-gage tracks that curve with the radius of the gate structure. The derrick forms the bulwark of the excavation and concrete handliag plant, though it is supplemented by several crawler cranes, a shovel or two, trucks and shale cutting saws and augers.

The first order was to strip the site of the gate foundations and to excavate for the foundation slab. Then the auger rig moved in to sink the deep holes. This boring machine, described more fully in the issue of Jan. 9, 1936, consists of a 5-ft. split disk at the lower end of a jointed shaft. The shaft, hanging from a crane boom, is rotated by a 40-hp. electric motor mounted on a gear box at the upper end, and is steadied by a telescoping torque arm attached to a lower corner of the boom. After the auger has cut for a foot or so, the cuttings are removed by hoisting the entire assembly, swinging it to one side and tilting the disk by means of a tag line after a pin connection in a shaft joint has been temporarily removed. As soon as the hole is bottomed, the sides are swept clean and sprayed with the usual bituminous sealing compound to check air slacking. When a group of holes has been put down, they are filled with concrete, encasing a cage of reinforcing bars.

As described in the article previously referred to, the deep cutoff trench at the upper side of the gates was excavated by shale saws, which cut vertical slots for the trench sides, and the interior core was removed by clamshell bucket after light blasting. As fast as sections of the trench were excavated, they were

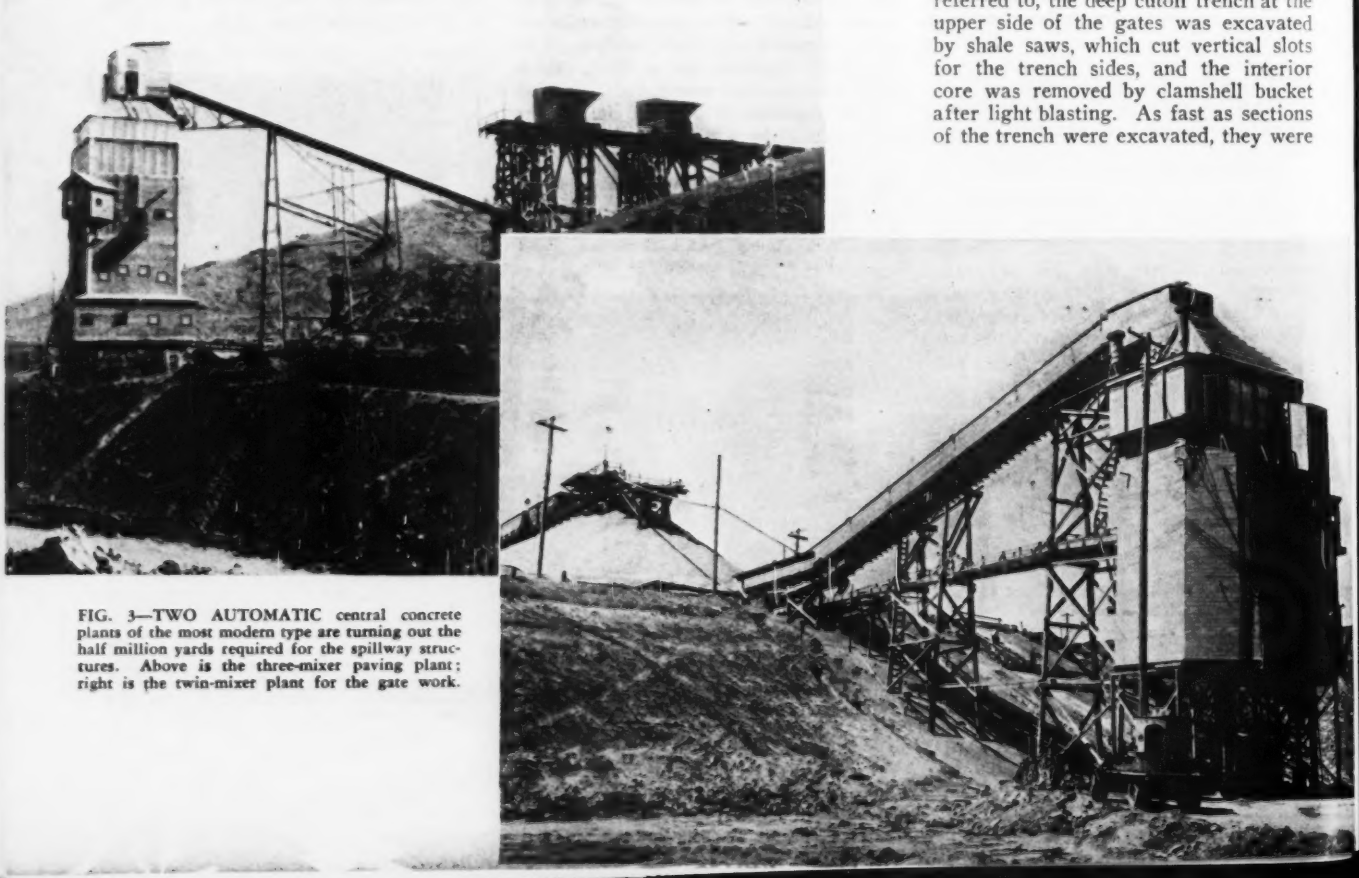


FIG. 3—TWO AUTOMATIC central concrete plants of the most modern type are turning out the half million yards required for the spillway structures. Above is the three-mixer paving plant; right is the twin-mixer plant for the gate work.

braced with steel wales and struts and then filled with concrete.

The contractor has developed an unusual arrangement for placing of the heavy main foundation slab, 75 ft. wide and 12 ft. thick. Concreting is done in blocks 52x75 ft. in plan, formed by wooden panels securely braced from the outside. Reinforcing of the slab is unusually heavy.

As a typical foundation pour takes about 16 hr., it was necessary to devise some means of pouring the concrete through the maze of reinforcing without coating the upper bars prior to their encasement. To meet this requirement a nest of 25 hoppers with sectional spouting or elephant trunks is set up on a framework of structural steel and timbers, supported by the form and additional blocking (Fig. 6). The hoppers are not shifted during the pour. At the start of a pour, the spouts extend nearly to the bottom of slab. As the forms fill up, successive sections of spouting are removed.

Concrete is supplied by a central mixing plant and is hauled to the forms by truck in 2-yd. conical roller bottom dump buckets. Three flatbed trucks, hauling one bucket at a time, are in use to keep the hoisting cranes going at top speed. Buckets are handled from truck to hoppers by the traveling derrick that serves the upstream section of the form, and by a crawler crane. Internal-type pneumatic vibrators puddle the concrete.

To spot the buckets over the hoppers quickly and accurately, the derrick has been equipped with a niggerhead line leading to the lower fall blocks of the hoist line. An ingenious arrangement on the cranes accomplishes the same purpose. Here the fairleads have been rigged up with a pull-line, working through an auxiliary sheave attached to the lower fall blocks.

The heavy retaining walls at the sides of the cut and the long training walls extending downstream from the gates are formed with steel panels (Fig. 6). Concrete placement is by bucket and crane, the same as for foundations.

Steel erection

There is considerable structural steel in the gate supports and guides, which must be erected to very close tolerances. The structural steelwork consists of horizontal frames and vertical members, with rods and turnbuckles for sway-bracing. The gate guides are carefully machined, and an attempt is made in erecting these members to place them with precision equal to that of the machining. This requires an elaborate temporary sway-bracing and plumbing arrangement. Extreme changes of temperature, ranging from as high as 120 deg. in the afternoon to 60 deg. at night, add difficulties to steel erection.

The contract for the gate structure includes paving of the sides and floor of part of the approach channel. Floor slabs are simple to place, but the paving of the side slopes involves some difficulties. The slope paving is anchored by vertical trenches, the sides of which are cut out by shale saws traveling up the slope on rails, pulled by a hoist at top of bank. Pneumatic chisels loosen the shale core between saw cuts, and the material is scraped to the bottom of slope by a cable-operated scraper.

The transition between the sloping sides of the approach channel and the vertical retaining walls at the gate structure is a warped surface. It was to the contractor's advantage to strip the overburden off the transition section far in advance of slope paving. To protect the exposed surface of the shale against disintegration, the usual treatment of bituminous sealing solution was applied, followed by a ¾-in. thickness of gunite, spread over chicken wire.

Paving the spillway

The paving of the floor and lower side slopes of the spillway channel for nearly a mile below the control gates offers a real problem of job management. The discharge channel narrows from a maximum bottom width of 710 ft. at the gates to a minimum of 130 ft. in the first half mile. The paving contractor's only access to the bottom of the deep cut is about mid-point on one side, and at the lower end. Floor slabs must be laid in sections 20x40 ft., doweled into adjoining sections on all four sides, with joints protected by continuous, welded steel sealing strips. Prior to placing of concrete, however, the protecting overburden of shale must be stripped off and the side slopes trimmed (amounting to some 1,000,000 cu.yd. of excavation), the drain tile ditches excavated, and the drain pipe laid in a bed of gravel.

The contractor must carefully plan his work to dovetail the various operations together to keep the job moving smoothly and, most important of all, to keep the sequence of operations from getting tied up. Providing access to all parts of the job without fouling work under way is a constant problem.

Stripping of the 8 ft. depth of overburden is by power shovels, loading into trucks for a long haul to disposal banks at the extreme lower end

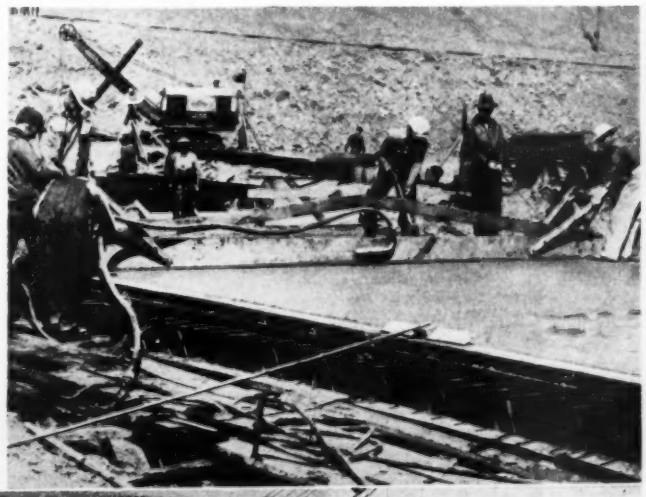


FIG. 4 — SPILLWAY FLOOR SLABS are leveled off with a heavy screed carrying a vibrator and are finished with wood floats.

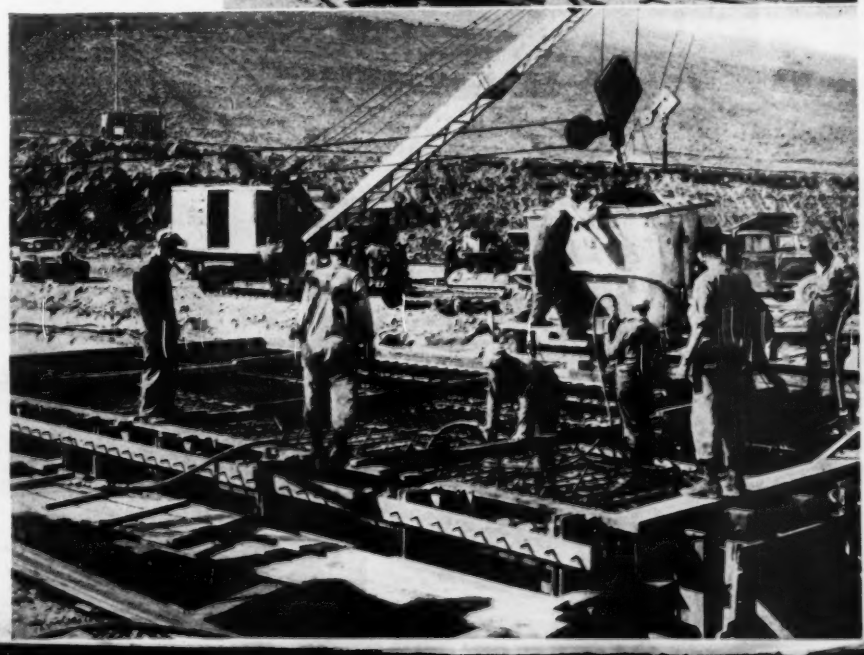


FIG. 5—POURING OF SLABS is by crane and dump bucket. Note the pull-line on the hoist sheave for spotting the buckets.

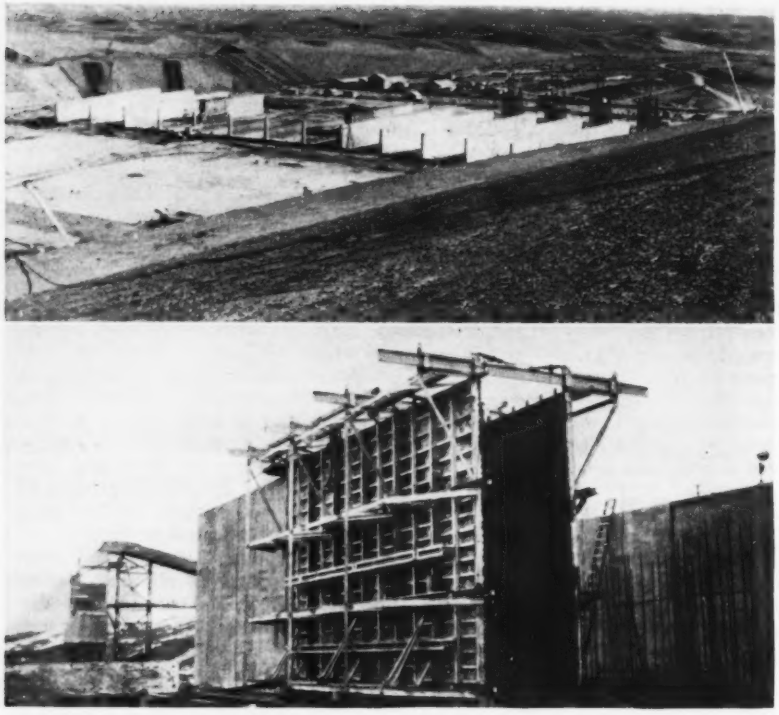
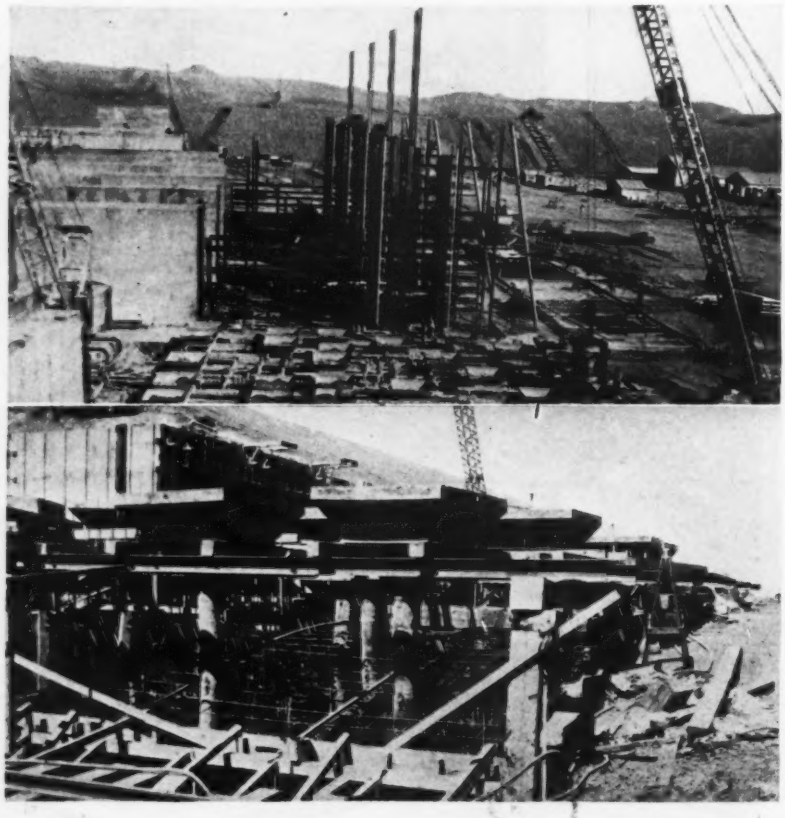


FIG. 6—THE LONG TRAINING WALLS are an impressive part of the gate structure. They are being built within traveling steel form panels. The upper view is looking upstream.

FIG. 7—THE POURING ARRANGEMENT for gate foundation slabs includes nest of hoppers with sectional spouting. Structural steel for gate supports is shown in upper view.



of the cut, a maximum round trip of two miles. Cutting of the drainage trenches follows immediately behind the stripping operations.

In cutting out of the 31 miles of drainage trenches a new tool of construction—the shale saw—plays an important part. Twin electric-powered saws are mounted on an adjustable steel frame, which rides on 20-ft. gage tracks. The saw rigs, set back to back, are equipped with blades 8 ft. long, over which cutting teeth travel on an endless chain. The blades operate in any position from straight down to straight out, giving any depth of cut desired up to 6 ft. Furthermore, the saw rigs can be tilted to any position from vertical to an angle of 45 deg., permitting the machines to make vertical or sloping cuts (Fig. 2). The adjustable carriage allows spacing of the cuts to any width up to 20 ft.

The saws cut a kerf 3 in. wide, advancing by an automatic cable feed arrangement at a speed of 9 to 20 in. per minute. The free ends of the feed cables are attached to an equalizing bar on a tractor. When the assembly has pulled itself up to the tractor, the tractor is moved ahead, reeling out the feed cables. Power for the saws is supplied through a portable transformer, mounted on a truck, which moves on a berm along the side of the cut, keeping abreast of the saw rig.

Even the saw cuts are susceptible to the rapid disintegration resulting from exposing the freshly-cut shale to air. Therefore, the kerfs are immediately backfilled with shale cuttings, tamped into place by hand. Occasionally, when vertical cuts are to stand for a considerable time, the kerfs are filled with cement grout, in which is embedded chicken wire, as a more permanent protection.

Trenches scooped out

Except for the main longitudinal drain, all trenches are cut with sloping sides of 45 deg. The core between saw cuts is scooped out by a pull shovel, working backwards, and loading into trucks (Fig. 1). The final trimming of the trench bottom is by hand, the spoil being loaded into buckets hoisted to the trucks by a job-made tractor crane. As fast as the trenches are excavated and trimmed, the sides and bottoms are treated with bituminous sealing solution.

At his central concrete plant, the paving contractor has provided a spout from the ¾ in. gravel bin to the outside of plant, within reach of a truck carrying a 2-yd. bottom-dump concrete bucket for loading gravel. Hauled to the trench location the bucket, handled by a crane, deposits the gravel for bedding the tile as needed. Placing of the drain tile is simple, most of the pipe being 6 in. in size and easily handled.

The two transverse edges of each 20x40-ft. floor panel are directly over the center of a V-shaped drainage trench, which complicates the form setting. Forms are wood panels of various heights, as the trenches vary in depth.

Some outside bracing is used, but the main form ties consist of welding a few bars in the top reinforcing mat to dowels already in place in adjacent completed slabs. The opposite ends of the tie bars are welded to a free dowel protruding through the form and held by form clamps. Most of the reinforcing for each slab section is built up within the form, but the top mat is fabricated outside, hauled to the site on a long trailer, and lifted to place by a crane.

Installation of the steel sealing strips is a tedious job. After the strips are in place in the form, one-half the width is painted with bitumen to prevent bond and to permit movement of the joint.

Concrete placing

A central mixing plant set on the west slope about midpoint of the cut supplies all concrete for the floor and slope paving. From the plant, concrete is hauled by trucks carrying square 2-yd. roller-dump buckets. At the form the buckets are handled by cranes (Fig. 5). The same ingenious arrangement of rigging up the fairleads of the cranes for spotting the buckets, as used at the spillway gate structure, is effective in placing the concrete where desired. As concrete is placed, it is constantly puddled with internal vibrators. A 20-ft. screed, on which vibrators are mounted, levels off the surface. Final finishing is by long-handled wood floats (Fig. 4).

The floor slabs are cured by water, applied to a covering of burlap, for twelve days. Curing by water adds to the contractor's difficulties, for excess water spreads over adjacent areas, and is tracked over walkways and roads by truck tires and workmen's shoes. This creates a slippery and dangerous condition, for even a slight wetting of the shale makes it slicker than grease.

Work continues 24 hours a day, six days a week. From ten to eighteen slabs are poured daily, averaging 100 cu.yd. each. With favorable weather, the contractor expects to finsh the paving work this season.

Paving of the lower side slopes is just getting under way. The most interesting feature of this work is the traveling steel form of cantilever type shown in Fig. 8. Stirrups are cast into the heavy floor slab close to the foot of slope. These are used as anchors to tie down the lower end of the form, for placing of the wall concrete develops considerable uplift on the form. In fact, this uplift is so great that it was found necessary to extend the tie-down beam beyond the form limits to catch additional stirrups. Concrete buckets are hoisted to hoppers set on top of the form.

The two central concrete plants on the spillway work are of the most modern type, equipped with heating facilities for cold-weather operation. Though planned and erected by two different contractors, the plants are similar in design except for cement-handling facilities and arrangement of mixers (Fig. 3). Bulk cement is used at both plants. At the gate structures cement is unloaded from box cars by a portable pumping unit; for the paving job a power scraper does the trick.

Both plants are similarly situated on the sloping side of the cut. Aggregate cars are dumped from a high trestle over a timber tunnel. A belt conveyor extends from the far end of tunnel to storage bins at top of plant. The mix requires three sizes of aggregate—¾-in. and 1½-in. gravel and sand. Batchers are of the automatic weighing type. The plant at the gate structure is equipped with two 2-yd electric-drive tilting mixers, while the paving plant mounts three cascading mixers discharging into a central funnel.

Direction

Lt.-Col. Thomas B. Larkin, U. S. District Engineer, is directing the Fort Peck project, and Maj. Clark Kittrell is chief of operations. Capt. John R. Hardin is in charge of all spillway work.

Addison-Miller, combined with Fielding & Shepley, Inc., both of St. Paul, Minn., have the contract for the spillway gate structure, the approach channel paving and the cutoff wall at the lower end of the paved discharge channel. H. C. James is superintendent for the combined firms. Paving of the channel walls and floor is part of the contract held by Massman Const. Co., of Kansas City (Spillway Builders, Inc., agents) for excavation of the spillway cut. A. D. Harvey is their superintendent. D. M. Hollingsworth, of St. Louis, Mo., inventor of the shale auger, is subcontractor for the sinking of the gate foundation pile holes.

This is the last of the current series of articles on the Fort Peck project. Previous articles in the series were published as follows. *Impressions of a Year's Progress*, July 23, 1936, p. 105; *Dredge Plant Characteristics and Hydraulic Fill Operations*, Aug. 6, 1936. p. 188; *Enlarging and Lining the Tunnels*, Aug. 13, 1936, p. 238; *Grouting the Tunnels*, Aug. 20, 1936, p. 274.

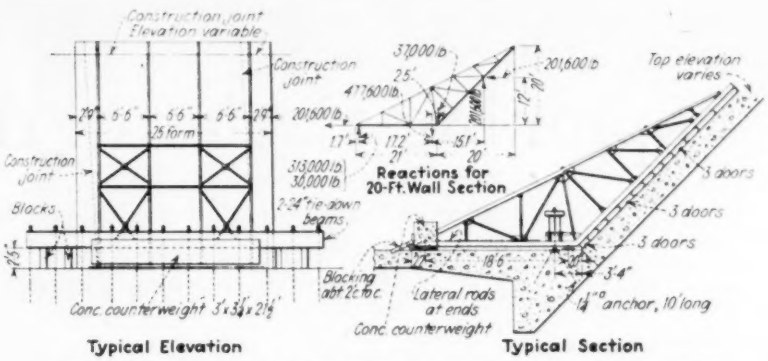
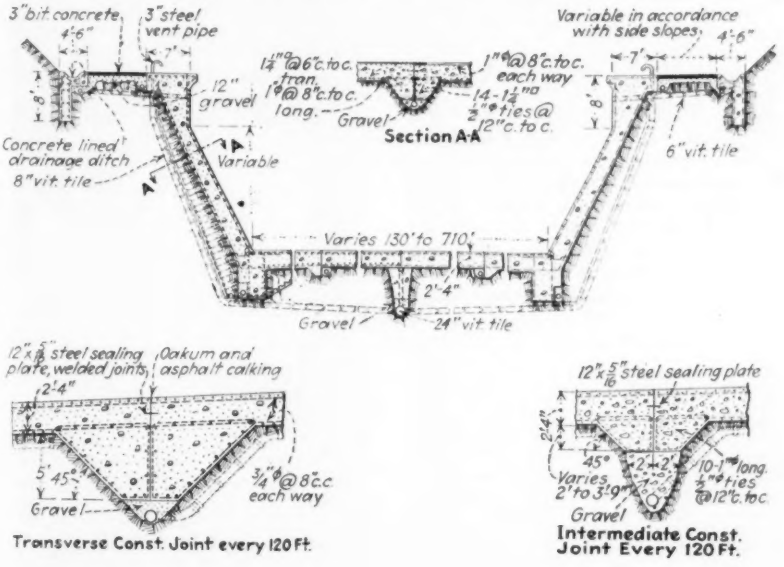


FIG. 8—THE TRAVELING STEEL FORM of cantilever type for placing the wall lining requires heavy anchors cast in floor slab to resist uplift.

FIG. 9—CROSS-SECTION OF SPILLWAY WALL and floor paving, showing drainage details. The floor is placed in 20x40-ft. slabs; the walls in 20-ft. sections.



Spinning Cables in the Saddles

Operations on Triborough suspension bridge at New York develop some new details and procedures for a cable spinning method that has many advantages

By J. H. Leon
Assistant Engineer
American Bridge Company
New York, N. Y.

CABLE SPINNING on suspension bridges has followed one of two methods. In the older and more frequently used procedure, the individual strands of the cable are built up in temporary positions paralleling the main cable but outside of the saddles on the towers and cable bents in which the strands ultimately rest. In the second and more recently adopted method, the strands are laid up directly in the saddles. Each method has its good and bad points. Believing that the advantages of spinning in place outweighed the disadvantages, the contractor for the Triborough suspension bridge cables elected to use the second method. In the development of the plan of attack and the prosecution of the work, several new details and procedures were introduced that constitute contributions to cable spinning practices.

In addition to its main span of 1,380 ft., over the East River, the Triborough bridge has side spans 704 ft. 8 in. long from the towers to the cable bents which change the slope of the cable from practically horizontal to 45 deg. where it enters the gravity type anchorage (*ENR*, Aug. 8, 1935, p. 177). The backstays between the cable bents and the anchorages are about 80 ft. long. Each of the 20¾-in. diameter parallel wire cables is composed of 37 strands of 248 wires each. The major spinning equipment was not essentially different from that used on previous bridges and included footwalks, timber-bent-supported tramways for hauling the spinning wheels and wire reels and accessories on the anchorages. During spinning, the towers (*ENR*, Aug. 15, 1935, p. 218) were deflected shoreward by cables connected to their tops while the inclined cable bents were allowd to rotate slightly about their base and were supported on temporary steel falsework.

Advantages of spinning in the saddle

The advantages and disadvantages of the spinning-in-place method may be briefly summarized as follows. The operation of adjusting the strand shoes at the anchorages is relatively simple. The long and cumbersome strand legs at the anchorages are replaced by compact and comparatively simple legs. The heavy and expensive lifting equipment required to transfer the completed strands from their spinning positions into the saddles at the tower tops as used in the older method, is eliminated, as is the danger of dropping a strand when transferring it from its temporary to final position. Finally, narrower footwalks are permissible. Against these advantages there is the objection of small clearance at mid-span between the completed strands and those being spun; also of small lateral clearance between the several strands spun in the same set-up. In addition, there is the real difficulty of laying up the strands in the saddles in a manner to give the proper shape of cable in the saddles.

FIG. 1—TRIBOROUGH suspension bridge as seen from beneath its viaduct approaches during the cable spinning period.

On the Triborough bridge all of the advantages were realized including a reduction in width of the footwalk from about 11 ft., as would have been required for spinning outside of the saddles, to 7 ft. The narrower footwalks permitted a saving of nearly 50,000 bd. ft. of lumber and required only two ropes for their support. How the disadvantages were overcome will be evident as the procedure is outlined.

Clearance between strands

In the first place, there was the necessity for maintaining clearance between the strands being spun and between these strands and those already completed. Lateral clearance between the strands being spun was obtained by sets of vertical bars placed at intervals along the footwalks. There were usually three bars in each set spaced laterally a distance of about twice the diameter of the strand and high enough that their tops projected above the strands. The lanes thus formed not only forced each strand away from its neighbor but also eliminated the danger of placing wires intended for one strand with those of the adjacent one. For the first set-up, these bars were short sticks nailed to the footwalk. Subsequently, steel rods about 18 in. long were substituted and inserted in holes in plates clamped to the portion of the cable already spun.

Vertical clearance between the completed strands and those being spun was obtained by spinning each strand, after the initial set-up of four strands, with a sag at the center about 12 in. less than normal. This clearance diminished to zero at the saddles where the strands were spun directly in their final position. On either side of the saddles, plates about 2 in. thick were placed between the strands and the completed portion of the cable. To obtain the subnormal sag at the center and yet spin the correct length of strand, the strand shoes at the anchorages were supported, behind their normal position on the eyebar pin, a distance of about 6 in. on either end. A short, compact strand leg was developed for this purpose. By using more than the normal amount of shims (4 in.) in the leg greater midspan clearance was possible, but was not needed.

Slight modifications in the usual methods of spinning in the short backstays were also made. In common with usual procedure, a temporary splay casting, in which the strands were placed after being spun, was used. This casting was installed at about the point where it was intended to apply the permanent splay casting, or about 25 ft. ahead of the strand shoes. The de-

sign of the falsework for the cable bent had provided a bracket for the support of this temporary casting.

Another departure was made by the introduction of supports for laying up the wires of each strand at the temporary casting. Ordinarily the strands are spun directly from the strand shoe to the temporary position outside the cable bent saddle. To have followed a similar procedure on the Triborough bridge would have meant spinning the strands directly from the strand shoes to their permanent positions in the saddle with a consequent sharp change in direction. This change in direction would have been particularly marked on those strands that connected to the outer lines of eyebars, and these strands would have crowded against the sides of the saddle rendering it difficult both to maintain the shape of the strand and to lay up the cable in the saddle in the desired manner. The introduction of the intermediate support transferred the break in direction to this point and allowed the strands to enter the cable bent saddle in about their final position.

The supports were in the shape of small cast steel saddles with an opening approximating the circular shape of the strand. They were placed on adjustable brackets bolted to the splay casting and could be raised or lowered to accommodate the particular set of strands being spun. Had the small saddles been maintained at an average elevation for all strands, the splay of the cable would have rendered it necessary to tie down each of the wires of the upper strands.

After each strand was spun and seized in its circular shape, it was transferred to its proper position in the temporary splay casting by stiff-leg derricks placed on each anchorage. The strands in the upper half of the cable were lashed down to resist uplift.

Procedure at tower saddles

The most difficult problem encountered was that of spinning the strands in the tower saddles. Little precedent existed on which to base an acceptable method since procedures on previous structures had sometimes not proved satisfactory. On one bridge, the cable groove of the saddle was redesigned to accommodate the strands spun in place. On the Triborough bridge the saddles had already been fabricated and such redesign was not possible. On another bridge, the strands had been spun directly in a saddle designed for circular strands and with little effort made to have the individual strands conform to the shape of the cable groove; the result was a general slumping of the wires in their tendency to fill up the voids usually left between circular strands. The designing engineers of the Triborough bridge desired that the strands should fill up the space in the saddle groove which the design contemplated in order that the centerline of the cable should

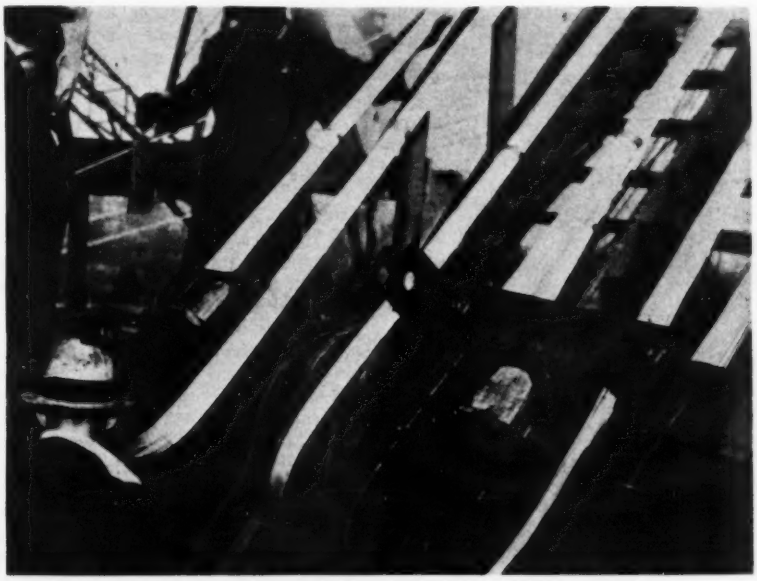


FIG. 2—COMPACT STRAND LEGS held the shoes 6 in. behind their normal position during spinning, providing 12 in. vertical clearance at midspan between completed strands and those being spun.

FIG. 3—SHEET METAL FORMERS in the tower saddles accommodated the strands as they were spun. View shows setup (the fourth, see Fig. 6) for spinning strands 13, 14, 15 and 16. Formers for strand 17 contains wood plugs; for strand 13 the formers are supported by wood blocks and steel stakes.

be at the correct elevation. This difficult requirement was met by the method adoped.

Into each saddle was inserted and allowed to remain permanently a series of containers or "formers" of circular cross section for each strand. These formers were open on top to admit the individual wires composing each strand, were made of a thickness to compensate for the absence of the seizing the design of the saddle contemplated, and were of sufficient strength to resist the stresses caused by the tension in each strand.

The formers were made from 6-in. widths of No. 13 gage full-hard, cold rolled strip bent to a radius that gave an inside diameter equal to that of the circular strand. The length of each strip so bent was such as to leave a ¾-in. slit at the top. In effect, the formers for each strand constituted a discontinuous pipe made up of pieces 6 in. long spaced on an average of 12 in. on centers; each transverse row of formers was carefully placed, so that it would bear directly on the one below it.

A clear description of the use of the formers may be had by briefly reviewing the actual design of the saddles which assumed that the strands would be spun outside. The calculated diameter of a strand (which was actually realized) was 3 7/16 in. The portion resting on the saddle was specified to be wrapped continuously with 1/16 in. seizing wire, making a total diameter of 3 7/16 in. The design of the strand grooves then assumed a slump of the strands to a shape approximating an ellipse of 3 11/16 in. major axis and about 3 7/16 in. minor axis. The radial distance between centers of rows of strands was 3 in.

To meet these dimensions, the outside diameter of the circular formers was made 3⅜ in., or 1/16 in. less in horizontal dimension than the corresponding dimension of the strand groove. The outward pressure of the wires in the former and the radial pressure of strands in the rows above were sufficient to flatten out the formers until they attained exactly the final elliptical shape required. Measurements indicated that in all saddles the centerline of the completed cable was within ¼ to ½ in. of the correct elevation, in all cases being above the theoretical position.

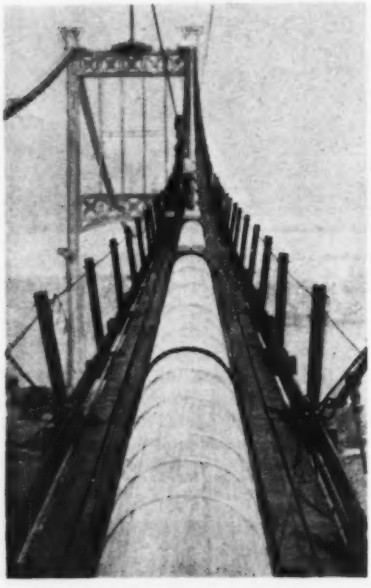
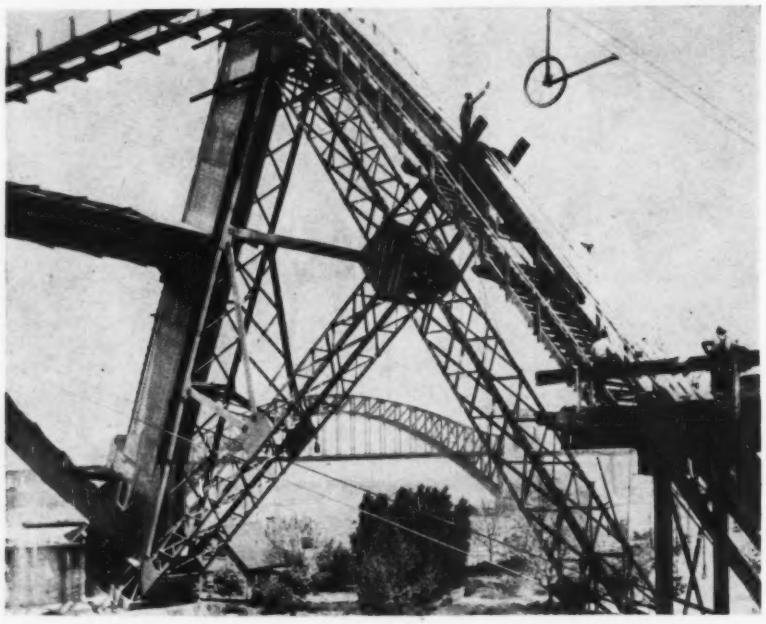


FIG. 4—NARROW FOOTWALKS, 7 ft. wide, provide ample working space. Suspender clamps are being installed on the compacted 20⅝-in. diameter cable.

FIG. 5—TEMPORARY SPLAY CASTING carried on cable bent falsework included spinning supports set high enough to transfer the downward "break" of the wires to this point, permitting them to enter the cable bent saddle in about their final position.



The strength of the former in resisting the pressure of the wires inside was given careful consideration. The forces introduced by the wires in the lower half of the strand could readily be resisted. Above the centerline of the strands, however, the outward pressure of the wires was resisted only by the two cantilever arms of the formers which terminated at the ¾ in. slit. It was feared that the upper portion of the formers if left unsupported would be so deformed under these pressures that the next row of strands could not occupy its proper position. The desired support was supplied by a flat strip ¾ in. wide and 6 in. long, welded to adjacent formers on the lines of contact between the strip and the formers.

Several incidental advantages were obtained from these reinforcing strips. Formers could be welded together in groups for each layer of strands, the number in a group being determined both by the number of strands in the particular row and also by the number in that row which was being spun in the same set-up. The number of individual formers welded together into groups varied from two to five. For the 37 strands a total of ten groups was required. After welding, each group was galvanized.

A further advantage of the strips was the resistance they afforded the formers against sliding. This was important because in adjusting the strands from the sags to which they were spun to the final sags they had to be pulled through the saddles from 3 to 6 inches. It is probable, without some force other than friction, that the formers would have moved with the strand. Such movement might have been sufficient to have pulled the former off the one immediately below it. To have replaced it would have been difficult and to have allowed it to remain displaced would have set up dangerous bending stresses in the wires of the strands on which it would have rested.

Additional measures were necessary to insure the success of the formers. A detailed description of two of the ten set-ups will serve to illustrate these measures. The second set-up included four strands, 5 to 8. The former for strand 5 had nothing but the cantilever arm to resist the pressures of the wires of the upper half of the strand. To reinforce this arm, a ½-in. diameter steel bar was placed in contact with the former and the side of the saddle and tightly wired in place. The former for strand 12, which was not being spun at this time, had little strength to resist the accumulated lateral pressures of the other four strands in the row. Accordingly, hard wood plugs were driven to a tight fit in that former during the spinning of the four strands. When the spinning was complete, each strand was tightly seized with several flat bands be-

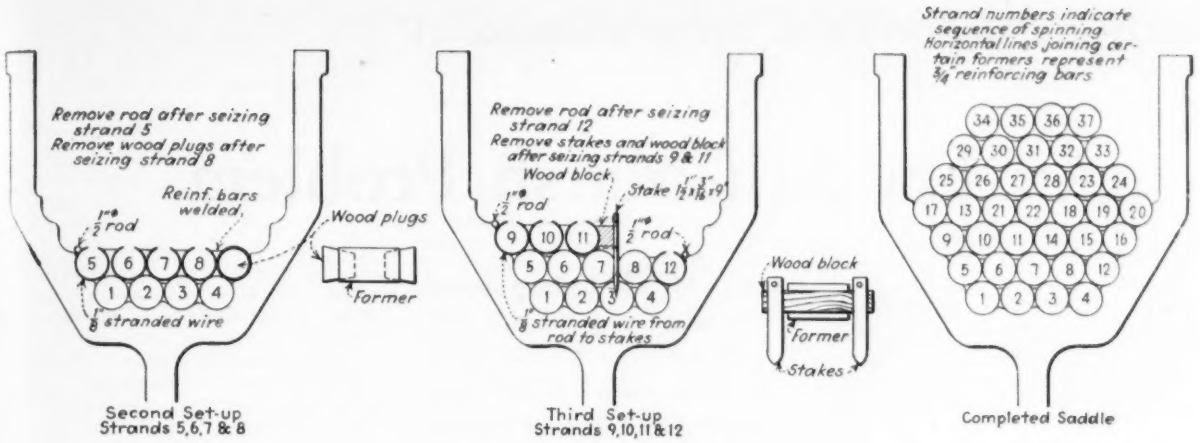

Remove rod after seizing strand 5
Remove wood plugs after seizing strand 8
Reinf. bars welded
1" rod
Wood plugs
Former
⅜ stranded wire
Second Set-up
Strands 5,6,7 & 8
Remove rod after seizing strand 12
Remove stakes and wood block after seizing strands 9 & 11
Wood block
Stake 1½ x ⅞ x 9"
1" rod
⅜ stranded wire from rod to stakes
Third Set-up
Strands 9,10,11 & 12
Wood block
Former
Stakes
Strand numbers indicate sequence of spinning
Horizontal lines joining certain formers represent ¾ reinforcing bars
Completed Saddle

FIG. 6—SPINNING DETAILS at the tower saddles for two of the ten set-ups.

tween each former; these were sufficient to preserve the proper shape of the strand so that the bars and plugs could be withdrawn.

The third set-up consisted of strands 9 to 12. The upper portion of the former for strand 12 was reinforced in the same manner as for strand 5. As is shown by the sketch, there was no reinforcing bar betwen formers for strands 11 and 14, since the six formers in this row could not be welded into a single group and still permit spinning strand 12. To support the entire side of strand 11, steel stakes 1½ x ⅞ x 9 in. long were driven between strands 7 and 8 and into strand 3. Two such stakes were used for the support of each former. Between the stakes and the former and fitting tightly against both was placed a block of wood about 10 in. long hollowed out to the curvature of the former. The stakes were of alloy steel with a high elastic limit. Additional support was given by wiring the rod used for strand 9 to the stakes. A rigid support for the former for strand 11 was thus obtained. After the completed strands were banded, all temporary supports were removed.

The use of the bars, plugs, and stakes, either individually or in combination, was repeated on each succeeding set-up.

The action of the formers was completely successful. They not only served their twofold purpose of allowing the strands to be spun directly in place and to the outline of the saddle, but also accomplished it in a manner better than has been done on some previous bridges where the strands were spun outside the saddle. It has not been uncommon in the latter method for the strands, even when tightly seized, to flatten to an extent that rendered it difficult to squeeze the last strand in the row into place. The use of the reinforcing strips eliminated this difficulty entirely, and in no case was there any trouble in spinning the final strand in a row. Patent covering the formers has been applied for.

The finished cable itself compared favorably with any on previous bridges spun by either method. After compacting, it measured 21 in. in diameter. Furthermore, it was uniformly circular in cross-section throughout its entire length. This permitted the cable bands to be placed with ease and to be drawn up to uniform bearing. The successful maintenance of the proper shape of the cable in the saddles contributed largely to this feature.

Accuracy of spinning was proven by the fact that the actual sags of the finished cable checked very closely with the theoretical. Fabrication of suspenders had been withheld until the actual sags were determined in order that any variation might be compensated in the lengths of the suspenders. In the majority of the six suspended spans (two side and one center for each cable) the variation of the observed sag from the calculated was less than 1 in.; in one span it attained a maximum of 2 in. The Triborough Bridge Authority then decided that these differences were negligible and that the suspenders should be cut to their theoretical lengths.

Actual spinning operations were begun on April 23, 1935, and completed on July 15, 1935. The total weight of wire spun in this period amounted to 2,805 tons, or an average of 52 tons per actual working day of 12 hours. In common with all cable spinning jobs, the first set-up consumed more than twice as much time as any of the succeeding ones. The average after the initial set-up was 61 tons of wire per day spun and adjusted. Maximum daily spinning was slightly in excess of 100 tons.

The American Bridge Co. was contractor for spinning the cables and placing suspenders, cable bands and other accessories, and responsible for the novel features of cable spinning described in this article. The cable wire and wire rope suspenders were produced by the American Steel & Wire Co. For the Triborough Bridge Authority, builder of the bridge, O H. Ammann was chief engineer; Allston Dana, designing engineer; H. W. Hudson, construction engineer; and H. R. Seely, resident engineer.

Use of One Simplon Tunnel For Highway Traffic Opposed

THE GOVERNMENT of Switzerland is opposed to using one of the twin Simplon railway tunnels for highway traffic, as has been actively promoted by highway interests in Switzerland, according to a report from the U. S. Consul General at Zurich. The proposal has gained popularity because it was thought that owing to the comparatively low expenditure involved it should soon be possible to obtain a new route under the Alps to Italy. The government, however, points out that the question of ventilating a tunnel 20 kilometers long (roughly 12.5 miles) presents quite a problem, the solution of which is more costly than the advocates of the plan believe. It is also thought that automobile traffic through the Simplon tunnel would not be large enough to justify heavy expenditures involved in providing ventilating equipment since most motorists would prefer to drive over the pass during the favorable season of the year, confining the use of the tunnel to winter months. Moreover, Switzerland could not carry out conversion of one of these railway tunnels without an agreement with Italy, because of a treaty with that country.

MOSQUITO CONTROL ENGINEERING—V

The Salt Marsh Problem

An adequate ditching system serves to carry off tide and rain water, gives ready access to larvæ-eating fish and forms the basis of control measures in tidal marsh areas where mosquito breeding conditions are ideal

By R. J. VAN DERWERKER
Superintendent, Union County Mosquito Extermination Commission, Elizabeth, N. J.

SALT-WATER MARSHES are by their natural formation ideally suited to the development of mosquitoes. In former ages, they were the shallow portions of bays, inlets and protected shofe lines where water plants could grow. These plants caught and held silt washed among their stalks and by this process built up the shallow portion of the bays with deposited matter. When these areas are raised to an elevation where only the higher tides of salt water inundate the marsh surface, conditions are suitable for the breeding of mosquitoes. These higher tides, generally occur due to storm winds building up the tides or on the full of the moon. Heavy rains flooding the marshes also supplies the necessary water for the development of mosquitoes. These marshes on the larger bays cover vast areas, every square foot of which may at times produce mosquitoes.

The salt-marsh group of mosquitoes includes those species commonly originating in the low-lying coastal areas common along the Atlantic and Gulf of Mexico shores and, to a lesser extent, the Pacific shore. Of the many genera of mosquitoes found in the United States, this group embraces comparatively few species. However, they are of major importance in the campaign of mosquito eradication due to their devastating influence on comfort and real estate values.

Tremendous swarms of these mosquitoes appear in certain areas at various times and due to their wide flight range, cover a large area to ferociously attack both man and animal. Greater concentrations of people are found within reach of this group than of other species because of rail and harbor centers at the seashore and the great recreation centers on the ocean beaches. One eastern state, containing 290,000 acres of salt marshes and some of the finest ocean beaches in the country, is situated so that over eighteen million people live within 150 miles of the center line of the state. This state fortunately commenced mosquito control early in the century and to date a six million dollar expenditure for eradication has increased shore and farm realty values one-half a billion dollars.

The following salt-marsh mosquito species are those which may be classified as economically important in various sections of the United States:

Aedes sollicitans, found throughout the Atlantic and Gulf Coasts, is commonly called the white-banded salt-marsh mosquito. Its wide prevalence in New Jersey at one time led to that state being dubbed "The Mosquito State."

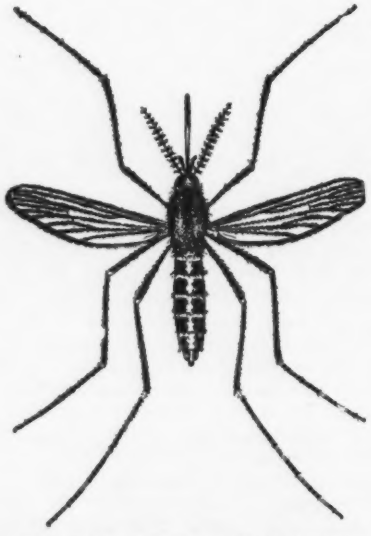


FIG. 1—THE PRINCIPAL SALT MARSH MOSQUITO—*Aedes sollicitans*. Note white markings on beak, legs and abdomen.

FIG. 2—KILLIFISH LIVE ON LARVÆ and are natural enemies of the mosquito.

Aedes taeniorhynchus, commonly called the small salt-marsh mosquito, is distributed over the Atlantic Coast and along the Pacific Coast from southern California, southward.

Aedes cantator is principally found on the north Atlantic Coast and seems to prefer waters of less salinity than the more generally distributed salt-marsh mosquitoes. It is found in the fresher areas of the marsh where streams dilute the salt water and it breeds more prolifically in the early spring and late fall when these streams are in their higher stages.

Aedes dorsalis is common on both the Pacific and southern Atlantic Coast.

Aedes squamiger has been taken in the coastal region of California.

Culex salinarius has been taken on the marshes of lower salinity in the Newark Bay area of New Jersey, so is listed as a salt-marsh mosquito. However, it seems to prefer the fresh or nearly fresh water bordering the marshes on the upland edges, where dilution occurs from fresh water streams. It is not considered economically important, but could become so if breeding conditions were ideal. Its distribution in the United States is considered east of the Mississippi River.

Anopheles quadrimaculatus and *Anopheles crucians* are both considered able to breed in the brackish waters of the salt marsh adjacent to the upland. Since the anopheline mosquitoes will be discussed under the malaria mosquito group (Article No. VI), the writer will not deal further with these.

There are four stages in the life cycle of a mosquito, namely the egg, larvæ, pupæ and adult. The principal salt-water marsh species pass through the winter or several winters in the egg stage. When the adult females have hatched, they generally deposit their eggs on the marsh surface before leaving the breeding ground.

Due to the many millions of mosquitoes that have been hatched from the salt marshes in the past, all these areas are well seeded with eggs. When a rain or tide covers the marsh, the eggs are naturally covered with water and some of them hatch immediately. Since large areas of the marsh are generally flooded by the rain or tide, millions of eggs are hatched at the same time. The

further development of larvæ and pupæ depends on the temperature of the water and the amount of food present and since these conditions are generally uniform over one area, all the adults hatch from the pupæ stage at about the same time. When this emergence takes place it is generally referred to as constituting a brood of mosquitoes.

Salt-water marsh mosquitoes are strong flyers and will rise and make their way inland for distances up to 40 miles from there nearest breeding place. The distance covered in these flights depends on humidity, temperature and favorable winds of not more than 10 mi. per hr.

Fish a natural enemy

The most effective natural agency serving to limit mosquito propagation in the salt-water marshes are the small fish that abound in the creeks and ponds. Members of the killifish group or *Fundulus* family are top-feeders and will eat mosquito larvæ or pupæ

Perhaps the most useful of these fish is the common killifish (*Fundulus hetoroclitus macrolepidotus Walbaum*). The females are nearly olivaceous in color while the males are dark greenish, with many narrow, irreguar, silvery bars on their sides. The sides are more or less spotted with white or yellow. This species reaches a length of 4½ inches and occurs throughout many salt marshes.

These fish are abundant everywhere to the limits of tidewater and at high tide penetrate to all parts of a salt marsh. They can live in sewage-polluted waters and the shallowest pools. As long as the water is deep enough for them to move they will work through reeds, salt hay and other vegetation. One seldom finds heavy breeding of mosquito larvæ in the same water that is populated by killifish.

While some salt marshes are at such an elevation that they can be kept completely free of mosquito breeding by the army of fish brought in by every high tide, other marshes are subject to flooding only on storm or lunar tides. In the interim they may dry up and the stranded fish die. Then, rains or so-called trickle tides, fill the depressions and holes which while not permitting the fish to get over the grass, produces a flooded condition which is ideal for mosquito breeding.

Most salt marshes are of this latter type and regular monthly broods can be expected unless artificial control methods are employed to permit the fish to enter flooded areas or other methods are employed to drain the water off the marsh surface and keep it off during warm weather.

A marsh, in order to produce mosquitoes, must hold warm water, free of killifish long enough for the mosquitoes to reach maturity. The logical procedure for mosquito control is to ditch the area so that surface water and water held in depressions will drop below the marsh surface with the fall of the tide; holes or pounds should be so connected that they will have a supply of fish at all times. Since the means for accomplishing this purpose should be easy to construct as well as economical to maintain, a ditch 10 in. wide and from 20 to 30 in. deep with perpendicular smooth sides has been adopted. The depth is varied according to the thickness of the soft, rooty material comprising the marsh surface and is also dependent on the tide fluctuation from the marsh. As the upland edge of a marsh is approached the bottom of the ditch should not go below the sand or clay bottom, unless the drainage of a pool or area beyond the edge of the salt marsh warrants such action.

Ditches should be opened to natural creeks or to wider main ditches if there are too few natural outlets. Several types of layout of these 10 in. ditches have been proposed, installed and tested but the most practical and most satisfactory of these seems to be the parallel system. In this system, the territory to be drained is divided into districts on the basis of possible outlets and each district is crossed by parallel ditches. The ditches, spaced so as to drain off surface water on the fall of the tide, are generally 300 ft. apart. This is not an arbitrary spacing but it may be varied to suit local conditions. Holes and other depressions are connected to these parallel ditches by spur ditches. It is important that every ditch should have a strong tidal outlet and no ditch with a single outlet should be over 1500 ft. long.

If the drainage work is carried on with hand labor, the sides of the ditch are generally cut with hay knives to the

FIG. 4—DITCHING MACHINE of the bucket and chain digger type which not only cuts the ditch but also breaks up the sod and scatters it to one side.

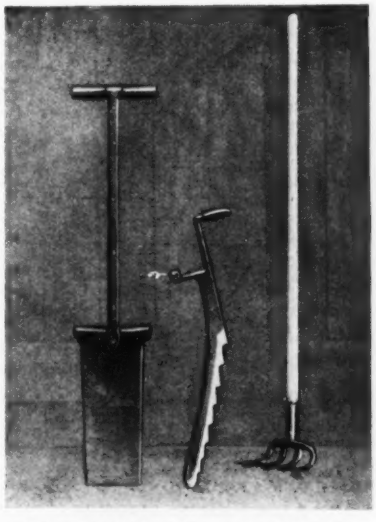


FIG. 5—TOOLS USED IN CUTTING SALT MARSH ditches by hand, a ditching spade, hay knife and sod hook.

FIG. 3—DITCHING LAYOUT illustrating the parallel system adapted to existing natural drainage.

desired width and depth. Then a special spade is used to remove the sods in blocks of 6x10 in. or 8x20 in. The sods are used to fill holes or they are piled in heaps to prevent any obstruction to drainage.

When large areas are to be drained ditching by special machines (with low ground pressure) is more economical than hand methods. In Atlantic County, N. J., a plow device, drawn by a tractor on wide caterpillar treads, removes the sod in a long, unbroken ribbon. Dr. Thomas J. Headlee of the New Jersey State Agricultural Experiment Station has developed a machine of the bucket and chain digger type. This machine not only cuts the ditch but also breaks the sods into fine pieces and scatters the material to one side. Cutting ditches by hand labor costs about 2c. a ft., and by machine about 1c. a ft.

On large areas of salt marsh, ditches are cleaned every three years, while on smaller areas they are cleaned annually. Annual cleaning, involving the cutting of grass at the edges of the ditch and removing debris and mud, can be done at a cost of 10c. per 100 ft. by hand; machine cleaning will cost about 25c. per 100 ft.

Closed marsh drainage

When the land along tidal waters is low (indicated generally by coarse grasses), dikes become necessary. In some cases, where sewage-polluted water (which generally stimulates breeding) empties into creeks running through the marsh, or where wind conditions may hold the water at a high tide level for several days, it becomes necessary to resort to the use of these dikes and automatic tide-gates to secure the required drainage for control. In other cases, the drainage established by nature has been so interfered with by the activities of man in building railroads, highways, dikes and banks that re-opening wide outlets and cutting ditches is not sufficient to control mosquito breeding. These artificial obstructions frequently cause changes in vegetation and sometimes a marsh will sink as much as 3½ ft. In extreme cases of marsh settlement, proper drainage cannot be accomplished by gravity alone through the tide gates, and pumping equipment must then be employed.

Dike Construction—Before diking, the first step in treating an enclosed marsh is the installation of internal ditching of the type used on the open marsh. The dike is generally placed 50 to 100 ft. from the banks of tidal streams and greater distances from the shores of bays or large bodies of water where wave action or heavy floating objects driven by storms may do serious damage. The height of the dike is determined by high tide elevations during the summer seasons which is generally about 3 ft. over the marsh. Allowance for shrinkage of at least 25 per cent must be made in determining the height. Winter and spring tides are not considered.

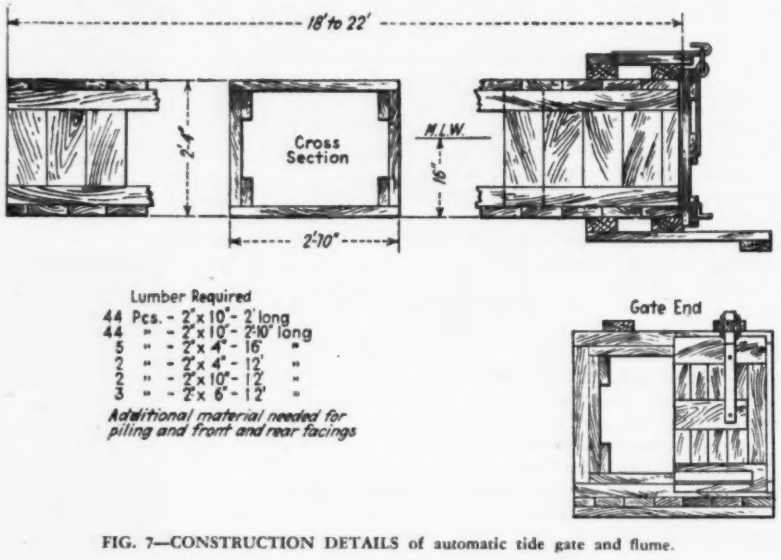

18' to 22'
2'-4"
Cross Section
M.L.W.
16"
2'-10"
Lumber Required
44 Pcs. - 2"x10" - 2' long
44 " - 2"x10" - 2'-10" long
5 " - 2"x4" - 16' "
2 " - 2"x4" - 12' "
2 " - 2"x10" - 12' "
3 " - 2"x 6" - 12' "
Additional material needed for piling and front and rear facings
Gate End

FIG. 7—CONSTRUCTION DETAILS of automatic tide gate and flume.

In beginning the construction of the dike, a trench 10 in. wide by 20 in. deep is dug along the center line of the proposed structure, and the sods removed are utilized in starting the base. A row of sods is laid on each side of this trench with the grass ends out. The width of the dike at the base may vary from 8 to 12 ft., depending on the height of tide which must be excluded and the amount of storm action to which the dike may be subjected.

When the first layer of sod blocks have been laid tightly together along the base lines, the center line trench and intervening space between the mud ends of the blocks are packed with mud. Then another layer of sod is laid on top of the completed bottom layer with the grassy ends inset about 6 in. from the lower layer to provide for a slope on the sides of the dike. The grassy ends of the sod must always be out. When the second layer line of sod is placed on either side of the dike, the center is again tamped with mud. Succeeding layers are placed in a like manner to bring the dike to the desired height. The width of the dike at the top should be 3 to 4 ft. and should be rounded over with a crest of mud.

Sod and mud for building the dike may come from the banks of adjacent streams or may be removed from a main drainage ditch constructed inside the dike for the purpose of intercepting the runoff from smaller 10 in. drains. If the material is removed from a ditch within the dike, this ditch should be located a sufficient distance (20 ft. or more) from the dike to prevent a weakening of the marsh surface against blow-outs during high tide periods. The grass in the sods will grow vigorously and transform the side of the dike to a solid grass-bound structure. In places where sods were not available dikes have been constructed entirely of mud but the maintenance cost on these is high because of erosion and storm damage.

A 4-ft. dike constructed by the writer with materials removed from a ditch 20 ft. away and measuring 8 ft. at the base, and 4 ft. at the top cost 48c. a lin.ft. The work was done entirely by experienced hand labor; no overhead was charged to the job.

Tide Gates—At points where streams or larger ditches cross the dikes, automatic tide gates should be constructed. These drainage gates should be located where there is a strong tidal outlet and where they are not subjected to the direct force of prevailing storms. Cross-sections of gate outlets are determined by the acreage of marsh to be drained and the volume of water from upland streams which they may have to carry. When no upland streams are diverted through the gate, one square foot of gate cross-section to 15 acres of salt marsh is generally accepted as a satisfactory method of computation although this figure is often increased by as much as 100 per feet.

In general there are two types of tide gates used—metal and wood. There are available several types of metal gates of varying sizes and circular in shape which may be attached to pipe by a specially built collar. These gates and pipes are treated against rust, and if solidly placed on a good foundation of piling, will last many years.

In using this type of gate, the pipe is generally supported by wood piling. At both ends shoring is placed to form a bulkhead, and the space between the two sides of the bulkhead is filled with mud. The bulkhead and pipe should not be less than 12 ft. in width and the width should be increased if the discharge is large or if the gate is subject to storm action. The sides of the bulkhead are

held together with tie-rods at the top of the bulkhead which is generally at or slightly above marsh level. The rods should also be placed through the bulkhead at a point about 3 to 4 ft. below the marsh surface.

Another type of automatic tide-gate is that constructed of wood. Wooden flaps, serving as gates, are either built on the ends of sluice-boxes or suspended against timber facings fastened to sidewalls of shoring. The first mentioned type of construction is cheaper and easier to install and can be easily repaired. A good tide-gate extensively used is the sluice-box type with a 2½x2 ft. cross-section; where more cross-section is needed, additional units are placed side by side in the bulkhead.

The lumber needed to build a gate and sluice-box of this type is 664 f.b.m. of fir or similar lumber, and 36 f.b.m. of dressed cypress for the gate flap. About 400 ft. of additional lumber for shoring to support the box and to close the ditch at the sides and top of the box must be included. In smaller streams or ditches, these gates may be installed by a crew of 7 to 10 men in one day, thus bringing the cost as low as $80 for some installations of one unit.

A disadvantage of the dike and tide-gate system of drainage has been the increased amount of ditch breeding of mosquitoes encountered due to lack of fish in the water which fails to drain from improperly maintained ditches. Recent investigations by the writer on a circulatory system for such areas seems to indicate that virtually all ditch breeding may be eliminated by admitting a supply of unpolluted salt water, charged with fish, into the sides and back of the marsh during high tides. This permits control of the water level to flush the small 10-in. ditches with clean water, and also stocks the ditches with fish.

Pumping—Pumps are used to control salt water marshes only when the marsh is shrunken so tide gates cannot remove the water soon enough to prevent breeding and the outlets are so polluted that circulation of fish can not be obtained. When such a marsh is to be handled all tidal waters must be blocked out and sufficient pumping equipment installed to remove not only rainfall but any sewage discharge coming in the area. When pumps are used, the water should be completely removed from the ditches before any breeding can take place.

Refinement of control methods

The three methods of control herein described vary in detail in different localities and under different men. Nearly every breeding area presents a more or less different problem but the basic principles and methods of control are much the same. While the open system of drainage is most generally used since it is the cheapest and simplest, it is not always the most dependable. As the work progresses, public demand for more complete and uniform control compels the eventual installation of the other two methods. However, since each refinement depends on the preceding system there is no money or effort wasted by developing from the open system to the dike and gate plan and thence to the addition of pumps.

When the control of the salt-marsh mosquitoes is accomplished, real estate development promptly occurs and increased ratables provide large dividends on the relatively small investment made. Increasing the comfort of people at home, at play and at work is appreciated by all in a community and by those who visit there.

Mosquito control progress may rightly be classed as one of the most satisfying and most productive accomplishments of the twentieth century toward the health and comfort of mankind.

The next article in the series, written by Dr. L. L. Williams, Jr., Senior Surgeon, U. S. Public Health Service, will deal with malarial mosquito control.

Land-Title Discrepancies Present Surveying Difficulties

Errors in original survey data raise title validity doubts for land improvement loan on Florida property

By Herndon P. Coloney
Project Engineer, Florida State Road Department

OFTEN it becomes the chief duty of the land surveyor not only to determine property lines but also to prove conclusively that the lines as they exist are the true lines and that the property owner has full legal right to the land that he occupies. The necessity for just such a survey was called for when a land owner in Manatee County, Fla., applied to the Federal Land Bank for a loan with which to improve his property. Discrepancies in the title description and the government plot caused the bank officials to conclude that a major portion of the land was being held adversely to the government.

The property, which lies in Lot 2, Section 6, Township 35 South, Range 17 East, had been acquired in two parcels. The first, which gave the difficulty in clearing title, was described as beginning at a point 1,320 ft. west of the southwest corner of Lot 2 as shown on the government plot, then running north to the south boundary of the adjoining property and then west to Palma Sola Bay, then meandering the shore to the range line, then south to the southwest corner of Lot 2 and east to the point of beginning. The other parcel began at a point south of the north corner of Lot 2 and ran west 1,320 ft., then south to the south line, then 1,320 ft. east, and then north to the point of beginning.

Discrepancies in title

In following the title description, the south line of Lot 2 was found to be 2,443.4 ft., as compared to the 20.4 rods or 1,346.7 ft. as shown on the government plot. The southwest corner of the first parcel, according to the deed,

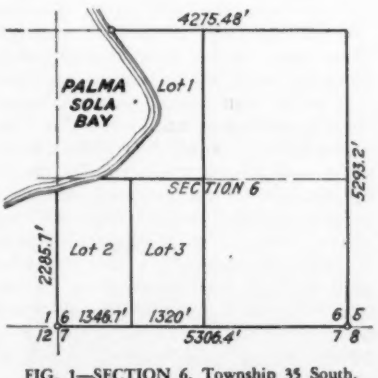


FIG. 1—SECTION 6, Township 35 South, Range 17 East, showing Lot 2 as laid out by original government surveys.

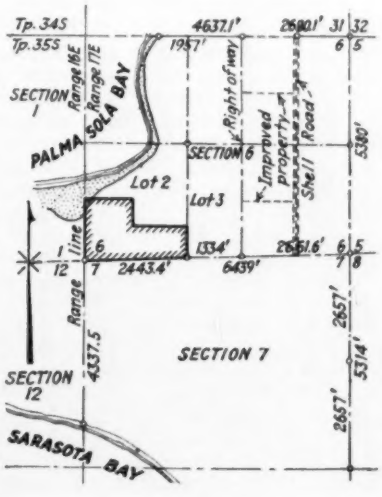


FIG. 2—LAYOUT of the section as it actually is, with the property in question shaded, shows much larger dimensions for Lot 2.

was on the government range line, and it also coincided with the southwest corner of Lot 2 and of Section 6. Thus it became necessary to show that the south line of plot 2 was actually long enough to provide for both of the parcels, and that although the section had been laid out incorrectly, the position of the bounds provided ample ground for the property to be the same as shown in the title deed to the two parcels in Lot 2.

Going back through the records, it was found that the original government survey of the range line between ranges 16 and 17 east, Township 35, was run by a United States deputy surveyor in 1844. During this survey the southwest corner of Lot 2 and of Section 6 was established as the common corner of Sections 1 and 12, Township 35 South, Range 16 East, and Sections 6 and 7, Township 35 South, Range 17 East. The north, east and south lines of Township 35 South, Range 17 East, had been run the previous year. The survey of Township 35 South, Range 16 East, was started from this range line by the same surveyor, who also sectioned the township in 1846, when he gave the length of the south line of the section as 80.40 chains, or 5,306.4 ft. Actually this line, between the corners established by this survey, measures 6,439 ft. This line is not only more than 1,100 ft. longer than reported by the surveyor but also bears to the south, the southwest corner of the section being over 400 ft. south of the southeast corner.

Frequent errors

Errors as large as this are unusual, but there are other instances in the same county of discrepancies occurring in the original survey. The surveyor's notes reported all the north and south lines of the south tier of sections in Township 34 South, Ranges 19, 20 and 21, as being 5,280 ft., when actual measurements showed them to be from 1,100 to 2,000 ft. short. The west line of Section 31, Township 34 South, Range 19 East, is only 3,037.4 ft. instead of the 5,280 ft. reported.

The exterior lines of Section 6, however, are well established, and the location of the range line is verified by a survey run in 1906 by E. B. Camp, U. S. deputy surveyor. Camp began at the northeast corner of Section 12, Township 35 South, Range 16 East, which, as can be seen from the illustration, is also the corner of the property in question. He describes this corner as "a lightwood post driven even with the surface of the ground in the center of the public road between Bradentown and Cortez." He also mentions that the corner is "generally well known, and all surveys in the surrounding sections are referred to it." From this corner he retraced the range line, 65.72 chains, or 4,337.5 ft., south to the shore of Sarasota Bay, where he set a meander corner. The post marking the southeast corner of Section 6 and of Lot 2 is still in existence and at the distance from the meander corner on Sarasota Bay to the northeast corner of Sections 7 and 12 as called for in Camp's survey notes.

Original measurements not accepted

The north line of Section 6 was used in starting a governmental survey in 1875 by a U. S. deputy surveyor, who at that time found the line well marked. The line is still well marked, as is the east line of Section 6. The southeast corner of Section 6 is marked and used for all surveys, so that the south line of the section is determined clearly by running a line between the two corners as located. This is, then, by actual measurement, 6,439 ft. long, rather than 5,306.4 ft., as shown by the original survey.

One reason for not accepting the original measurement is that the notes call for intersection with the range line previously established, and the Manual of Instructions for the Survey of Public Lands of the United States lays down the rule that in the restoration of lost corners, range lines and township lines shall be given precedence over section lines in locating corners that are common to both. It is also the general rule that the true corner of a government subdivision is where the government surveyors actually established it by monuments, regardless of the descriptions of its location.

Governmental rules also call for the use of proportional measurements in the subdivision of a section. The procedure is to identify or re-establish the boundary corners and then to fix the lines of the quarter sections. Smaller tracts are then formed by proportionate measurement, by which is meant a measurement having the same ratio as that between original field-note measurement and the length of the line measured in the resurvey.

On this basis the measure to be used on the south line of Section 6 would be a chain of 80.097 ft. rather than of 66 ft. Then the east half of the line would be the length of 40 of these long chains, while Lots 3 and 2 would get 20 and 20.4 chains, respectively. This would make the south line of Lot 2 only 1,633.77 ft. long, which would be much closer to the originally reported distance of 1,346.7 ft. than the present 2,443.4 ft.

Bounds prove property lines

If the rule for subdivisions of sections was strictly followed in this case, however, it would throw all property, improved and unimproved, in this section into confusion, and deeds, under which parcels have been held, would be almost impossible to follow. Government instructions for resurveys point out that it is best to accept lines based on local improvements rather than to upset satisfactory existing conditions. As a rule, the courts also accept the existing lines as marked as being the true positions of those lines.

Based on these findings, a report was forwarded to the Federal Land Bank, which accepted the land as being legally held by the applicant.

Concrete Slabs Under Concentrated Loads

A TEST PROGRAM carried out at Iowa State College as reported in Bulletin 126 Iowa Engineering Experiment Station, by M. G. Spangler, throws some new light on the distribution of shearing stresses in concrete floor slabs under concentrated loads. Previous work on the subject has dealt only with loads placed near the transverse centerline of the slab. The Iowa investigation studied the effective width to be used in concrete floor slab design by placing the concentrated load in a position to produce maximum shearing stresses, namely at a support. Begun in 1925, the studies have been expanded until data are now available on 20 rectangular slabs ranging in thickness from $2\frac{1}{2}$ to $6\frac{1}{2}$ in., in width from 5 to $7\frac{1}{2}$ ft. and in span from $3\frac{1}{2}$ to 10 ft. The data have been used in empirical working formulas for obtaining the effective width for shearing stresses in slabs under single concentrated loads, dual-tired wheel loads and the front wheels and opposite rear wheels of single trucks or passing trucks.

Among the conclusions in the report are the following:

(1) The effective width for maximum shearing stresses is independent of the span of the slab.

(2) The effective width for maximum shearing stresses varies with the thickness of the slab when the load is placed at a distance equal to or greater than $3.25\sqrt{t}$ from a free edge of the slab, and it may be expressed by the formula $e = 5\sqrt{t}$, where t is the thickness of the slab, and t and e are expressed in feet.

(3) When the load is placed closer to a free edge than in (2) above, the effective width $e = 1.75\sqrt{t} + d$ where d is the distance from the free edge in feet.

(4) The effective width for maximum shearing stresses is independent of the width of the load up to a width of $4\frac{1}{2}$ inches.

Bleachers for Ohio School Built of Reinforced Brick Masonry

By H. C. Plummer
Civil Engineer, Cleveland, Ohio

SOME REINFORCED brick masonry bleachers recently completed in Maple Heights, a suburb of Cleveland, Ohio, as a WPA project, have excited favorable comment regarding both the appearance of the completed structure and the economy and adaptability of the design. These bleachers were part of an athletic field project which involved the moving of 10,000 cu.yd. of dirt, placing 800 tons of cinders, laying 10,000 ft. of drain tile, constructing reinforced brick masonry retaining wall and bleachers, spreading top soil and seeding the two-acre field. Work was started on December 8, 1933, under the Civil Works Administration and progressed intermittently until the spring of 1936 when the project was completed. Since all dirt was moved by hand, the grading operations progressed rather slowly, and it was due primarily to this fact that something over two years was required to complete the project. Local authorities were handicapped also by the fact that the project was shut down for from two to three months during the summers of both 1934 and 1935, and that a large percentage of the work was done during the fall, winter, and spring months when the weather was unfavorable.

Built in the winter

The bleachers themselves were constructed during the fall and winter of 1934 and the spring of 1935. The winter was characterized by prolonged and continuous cold spells, the temperature remaining below freezing for weeks at a time. In order to make it possible to proceed with the construction of the bleachers, a tent was erected over the bleacher area and stoves were set up inside by means of which the temperature was maintained above freezing while the brick masons were at work. As an added precaution, the brick were heated before laying and the sand and water used in making the mortar were also heated. An effort was made to keep the temperature inside of the enclosure above freezing for at least 24 hr. after the brick masonry beams had been constructed. However, on one or two occasions, it is apparent that this temperature was not maintained, but that the temperature dropped from 10 to 15 degrees below freezing within a few hours after the brick had been laid.

Details of construction of the brick bleachers are shown in the accompanying illustrations. The brick riser beams are spaced 5.2 ft. c. to c. The rise is 7.35 ft., and the depth of the bleachers front wall to rear wall is 15 ft. Each beam is 13 in. wide (3 brick) and $11\frac{1}{4}$ in. deep with an effective depth, top of beam to center of steel, of $8\frac{1}{2}$ in. Reinforcing consists of four $\frac{1}{2}$ in. square bars, with shear reinforcement of two $\frac{3}{8}$ in. stirrups on 9 in. centers at each end of the beam and $\frac{1}{4}$ in. stirrups throughout the remaining lengths, spaced with 2 stirrups in each step. The $\frac{1}{4}$ in. stirrups extend above the top of the diagonal beam and are bent up into the steps.

A 12x12 in. brick pier is placed under the center of each beam, although the beams are not reinforced to take negative bending over this pier, the $\frac{1}{2}$ in. rods at the bottom being continuous from one end to the other. The increased stiffness obtained through the addition of steel in the bottom of the beams was relied upon to prevent excessive cracking over the piers. The beams were designed to carry a live load of 100 lb. per sq.ft., and the computed stresses induced by this loading, figuring two simple spans from front wall to pier and from pier to back wall, are 9,000 lb. per sq.in. in the steel and 405 lb. per sq.in. in the brick masonry.

After two-thirds of the beams had been constructed, a test load of 11,137 lb., about 150 per cent of the design live load, was placed upon one beam and allowed to remain for about two weeks. No cracks appeared in this beam and no measurable deflection (1/16 of an in. or more) was noted. A beam was selected for this test which had evidently been subjected to temperatures below freezing shortly after it had been constructed. The mortar in the joint containing the reinforcing steel had apparently frozen for a distance of from $\frac{1}{4}$ to $\frac{1}{2}$ in. from the outside of the beam toward the center. This frozen mortar could be scraped out of the joint very easily. However, beyond this point, the mortar seemed hard and in good condition. Results of the test verified this opinion.

The bleachers are about 300 ft. long and required 110,000 brick for their construction.

The reinforced brick retaining wall, also a part of the project, slopes upward from the ground to a height of 8 ft. It is 12 in. thick for the top four feet and 16 in. thick below this point. Reinforcing consists of $\frac{3}{8}$ in. round corrugated rods spaced from 6 to 12 in., depending upon the height of the wall. The reinforced brick footing upon which the retaining wall rests is 3 ft. below grade. Approximately 45,000 brick were required to construct the wall and footing.

In estimating the project, it was found that the cost of materials both for the

TESTING one of the reinforced brick masonry riser beams.

REINFORCED BRICKWORK bleachers which harmonize with the architecture of the nearby school building.

bleachers and for the retaining wall was less using reinforced brick masonry than with reinforced concrete due to the elimination of form lumber. In addition to the saving in material costs the architecture also harmonized with that of the existing school building.

This project was sponsored by the Maple Heights Board of Education, Ben Krinsky, architect, and was constructed under the supervision of the Cuyahoga County, Ohio Work Relief Administration, Kimball Johnson, director CWA and FERA and Waldo Walger and Joseph Alexander successively directors of WPA. The author is consultant to the Maple Heights Board of Education on its WPA projects.

Clean Streams for Wisconsin

A program of pollution abatement started ten years ago has resulted in marked progress in the construction of sewage treatment facilities on major watersheds—Developments in trade waste treatment

DURING 1935 the treatment of domestic sewage and industrial wastes in Wisconsin resulted in a material clean-up of the 28 major drainage areas into which the state board of health divided the state ten years ago when it started on a comprehensive program to abate pollution nuisance by watersheds. Of a total of 244 public sewer systems 136 now have treatment facilities and 12 new plants are under way.

While effective treatment processes were available for domestic sewage and some trade wastes, the board of health has found it necessary to conduct special studies to determine how some wastes could be utilized or disposed of in such manner as to prevent serious pollution of lakes and streams. The primary objectives in the utilization of wastes and treatment of sewage are stated as follows:

1. To remove solids responsible for odorous sludge deposits and other offensive conditions.
2. To prevent serious depletion of the oxygen content of the stream.
3. To destroy disease germs or bacteria endangering water supplies, bathing or recreational areas, and otherwise affecting the public health.

Activity on major watersheds

Reporting on the progress on the major watersheds, L. F. Warrick, state sanitary engineer, indicates the following: The Rock River clean-up program started in 1931, calling for at least primary treatment for all of the sewage from the 33 sewered municipalities located along the stream and its tributaries above the state line at Beloit, was practically completed by Dec. 31, 1935. The only plant that was not completed under this schedule is now being constructed at Jefferson. Beloit, while not yet provided with sewage treatment facilities, is providing for conveyance of the sewage through interceptors to the state boundary line, and tentative arrangements have been made with South Beloit, Ill., for the ultimate construction of a single plant in Illinois to take care of both communities. Necessary enabling legislation was secured in both states in 1931.

Excellent progress has been made in the Illinois-Fox river drainage area. Completion of the treatment plant at Burlington in May, 1935, was the last step in securing at least primary treatment for all municipal sewage discharging into this stream. Completion of the modern sewage treatment works now under construction at West Bend, and the ultimate connection of the village of Barton to this system, will complete a similar program in the Milwaukee River drainage area. The $1,300,000 sewage interception and treatment system being installed at Sheboygan and the construction of an intercepting sewer to convey sewage from Sheboygan Falls to the plant at Kohler, will complete the work of securing at least tank treatment for all of the sewage being discharged into the Sheboygan River.

Results of stream surveys having definitely shown that the Fox River was excessively polluted by sewage and industrial wastes, ways and means were considered for the most effective and economical reduction of pollution to a point where nuisances could be prevented, fish life preserved and the public health adequately protected. With the completion of projects started in the Fox River valley, all large municipalities with the exception of one, will have at least primary treatment. Five of the plants to be constructed will employ chemical precipitation.

A Green Bay Metropolitan Sewerage District was established Dec. 3, 1931, as the first step in caring for the sewage disposal problems of cities and villages along the lower Fox River. The initial program undertaken was to reduce pollution of the East River, a tributary entering the Fox River in Green Bay, which received 45 per cent of the local sewage. The intercepting sewers and sewage treatment facilities for this initial project have been completed during the past year, and the district is now proceeding with a PWA grant and loan to complete the program for intercepting all of the sewage being discharged into the Fox River at Green Bay.

Consideration was given to establishing a metropolitan sewerage district in the Neenah-Kaukauna area, but it was finally decided by the municipalities concerned that they would rather proceed independently with the establishment of sewage treatment works. In the case of Neenah and Menasha, however, it became apparent that the most practical and economical procedure would be for the cities to cooperate in building a single treatment plant to take care of their joint problem. Suitable legislation to accomplish this purpose was enacted by the 1935 legislature.

Neenah, Menasha, Appleton, Little Chute and Kaukauna are now proceeding with necessary improvements to clean up the Fox River with the aid of 45 per cent PWA grants. Marinette has finished its intercepting sewers and plans are now being prepared for a plant providing complete treatment. After La Crosse completes its sewage treatment facilities there will be only two municipalities in Wisconsin discharging raw sewage directly into the Mississippi River.

The industries involved in these stream clean-up activities have also given attention to their individual problems, with the objective of reducing wastes to a minimum. In some situations this has been accomplished to the economic advantage of the industry while in other cases the wastes from the plants are treated merely with the view of abating serious pollution.

Trade waste treatment

Outstanding developments in waste handling are briefly summarized as follows:

Malt House Wastes—A full scale plant to treat malt house wastes was designed and built at Jefferson Junction. It includes a 40-mesh rotary screen unit; a trickling filter (rotary type) 8 ft. deep, built of crushed limestone enclosed by a filter wall of concrete slabs formed with openings for adequate ventilation, and a settling tank provided with mechanical sludge collectors of the straight-line-flow type. The sludge is disposed of as fertilizer or fill material. The system was placed in operation during the fall and apparently is giving satisfactory results, even with sub-zero temperatures experienced this past winter.

Cannery Wastes—Further tests in cannery-waste treatment included a continuous-flow type chemical precipitation system provided with mechanical facilities for sludge collection and removal. The results indicated effective

treatment but no increase in efficiency over the fill-and-draw process used in all of the plants installed during recent years in Wisconsin.

Where essential, additional treatment for the effluents from these plants has been provided through municipal sewerage systems. Investigations have shown that if trickling filters were not overloaded they would provide a high degree of treatment for the canning wastes. Plant No. 1, located in a city of 2,000 population consists of separate sludge digestion, trickling filters and secondary sedimentation followed by sand filters. The cannery in this city has a chemical precipitation plant for preliminary treatment, following which the waste is pumped into the municipal system for further treatment.

Prior to the canning season, plant No. 1 was found to be producing 92.4 per cent reduction of 5-day B.O.D. and 88 per cent removal of suspended solids. At the time of this test the plant had been in operation for only a short time, and probably had not reached its maximum efficiency. A test during the pea-canning season indicated a 77.2 per cent reduction of 5-day B.O.D. and 81 per cent suspended solids reduction. During the beet-canning season the plant accomplished a reduction of 96.2 per cent B.O.D. and 95 per cent suspended solids. With a loading equivalent to 1 lb. B.O.D. to 20 cu.ft. of rock, the reduction by the filter and secondary tank amounted to 57 per cent, and with 1 lb. to 40 cu.ft., the reduction was 85 per cent; the sand filter reduced the B.O.D. of the secondary tank effluent 61 and 75 per cent, respectively.

Plant No. 2 consists of separate sludge digestion followed by a trickling filter and secondary sedimentation. Canning wastes were only screened at the factory but they were aerated for 2 hr. at the treatment plant before being mixed with settled domestic sewage previous to filtration.

With a loading of 1 lb. B.O.D. per 11 cu.ft. of rock, the reduction by the filter and secondary tank was 75.7 per cent. A loading of 1 lb. B.O.D. to 49 cu.ft. of rock caused a reduction of 88 per cent. The above would tend to indicate that there may be a distinct advantage in aerating the canning plant waste prior to treatment on a rock filter.

Pulp and Paper Mill Wastes—The outstanding development in the waste utilization and stream improvement program being carried out with the aid of the Wisconsin pulp and paper industry, was the installation of the Howard process for reclaiming pollutional substances in sulphite waste liquor on a mill-scale basis. The plant has only recently been placed in operation. Pilot plant tests indicated that the process has an efficiency of 75 per cent or better in the reduction of high oxygen demand characteristic of this waste.

Surveys of white-water systems and other mill wastes activities made during 1935 indicated further progress in reducing fiber losses below 1 per cent and volumes of water below 20,000 gal. per ton of product.

Tannery Wastes—During the early part of 1935 there were placed in operation two clarifiers for tannery wastes as an addition to an existing separate sludge digestion plant for municipal sewage at Fond du Lac. The sludge removed from the tannery wastes is lagooned at present but this procedure will be discontinued as soon as other methods of disposal are developed.

Studies previously conducted have indicated that up to 40 per cent by weight of the tannery sludge in a mixture with domestic sewage sludge could be digested. Provision has been made for pumping the tannery wastes into the two existing digesters and, aside from some foaming during the first two weeks after the experiment was started, no significant change has yet occurred in digestion conditions.

It is not anticipated that any serious difficulty will be encountered with the digestion process as long as the tannery sludge remains substantially below the 40 per cent tannery-sewage sludge limit. Since 1932 another plant, equipped with separate sludge digestion facilities, has been satisfactorily taking care of the relatively small amounts of tannery solids in combination with the sewage sludge. The tannery wastes in this instance are given preliminary treatment through a 20-mesh rotary screen unit to remove hair and fleshings prior to adding these wastes to the sewage at the inlet of the primary clarifier at the municipal plant.

With the renewed interest in chemical precipitation for municipal sewage treatment, and with successful sludge disposal by vacuum filtration and incineration, Mr. Warrick states, it is possible that a number of the larger industrial cities will be in a better position to cope with sewages containing fluctuating amounts of trade wastes known to be inimical to biochemical treatment processes. Chemical precipitation methods should also prove particularly helpful in solving problems created by seasonal industries.

Concrete Patched by Grout Sprayer

A GROUT EJECTOR small enough for one man to carry as he walks along, for filling bolt holes or smoothing up gravel pockets, has been developed on division 3 of the Metropolitan Water District of Southern California. This device, which is called the Mack Gun, is so light and convenient that it is adapted to patching jobs which ordinarily have been done by hand.

GROUT EJECTOR FOR PATCHING concrete surfaces, especially gravel pockets, is here filling form tie bolt holes. Note the hole in left foreground ready for treatment.

Essentially, the device consists of a small grout hopper whose base terminates in an elbow fitted with an air connection and a nozzle. A valve in the air inlet, conveniently located for control by the operator, admits air that shoots the grout out of the nozzle. The operator uses both hands to hold and steady the gun; his left arm passes over the hopper and his left hand grasps a handle on the far side of the hopper near the top. His right hand controls the air valve at the same time that it aids in supporting the gun.

Material for the gun is a mix containing about one part of cement to three parts of sand with the minimum amount of water necessary to produce the consistency necessary for spraying. The feed is by gravity aided by the suction of the discharging jet. A small hose is sufficient for the air supply; a ½-in. connection is used at the gun. Air pressures of 40 to 50 lb. per sq.in. have been found most suitable for operation of the device.

The device was developed by L. E. McCormick, foreman for Broderick & Gordon, contractors on the Colorado River aqueduct, which is being built by the Metropolitan Water District of Southern California.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

Concrete Building Design

THE DESIGN OF REINFORCED CONCRETE STRUCTURES—By Dean Peabody, Jr. Cloth; 6x9 in.; pp. 457; tables and charts. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London. Price $4.00.

REFLECTING as all text books do the author's ideas of instructional procedure, this new book on the design of reinforced concrete (buildings primarily) has the special characteristic of being planned for the man who must study without classroom instruction. The presentation of theory thus is followed by illustrative designs that are carried through to a point where a sketch may be made that is suitable for use by the field force. The order of development is rectangular beams, one-way slabs, tee beams, two-way slabs, columns, footings and retaining walls, continuous beams and arches.

The Slum Problem Analyzed

SLUMS AND HOUSING—Two volumes. By James Ford with collaboration of Katherine Morrow and George N. Thompson. Cloth; 7x11 in.; pp. 1,033. Illustrated. Published by Harvard University Press, Cambridge, Mass. Price, per set $10.

IN OVER 1,000 PAGES these two volumes set forth the results and conclusions of the most comprehensive study yet made of slums and the attempts to rid our cities of them. Based upon three centuries of experience in New York City, the study nevertheless has nationwide application. In the first place it is devoted to all aspects—economic, social, political and technical. Secondly it attempts to view our present approach to low cost slum clearance housing in historical perspective. Briefly, the causes and effects of temporary conditions are analyzed, and methods of slum prevention, of elimination of present slums and of rebuilding of slum areas are discussed in considerable detail. The roles of city planning, of legislative action in the interests of slum demolition and of governmental policy are statistically analyzed. A lengthy appendix by I. N. Phelps Stokes covers the development of tenement house plans in New York City and describes the many architectural competition programs for tenement houses held during the past half century. The evaluation of conditions, causes and measures of slum prevention, clearance and rebuilding contained in the book should aid in the clarification of objectives and the framing of a social policy adapted to contemporary conditions.

Mass Production of Housing

THE EVOLVING HOUSE—III—RATIONAL DESIGN—By Albert Farwell Bemis. Cloth; 6x9; pp. 625; Linecuts, tables. Published by Technology Press, Massachusetts Institute of Technology, Cambridge, Mass. Price $4.

THE FINAL VOLUME of this notable three volume work brings the author to grips with his chief adversary, the antiquated and unsatisfactory design procedures that rule house building. Mr. Bemis, whose untimely death occurred just as his third volume was going to press, began his studies with the preconceived idea that the chief factor in the housing problem is the physical structure itself, and that this only can be improved by mass production technique. However, being of scientific mind and a civil engineer, he first set himself the task of studying the history and present status of housing, and the first two volumes, reviewing respectively the evolution of the home and current housing conditions resulted. These were discussed in *Engineering News-Record*, Aug. 30, 1934, p. 280.

The third volume is devoted to a method of design based upon a simple concept of measurement—the cubical module, which provides a single unit of measurement in all three directions. Houses are essentially rectangular and their volume can be conceived as being made up of a matrix of cubes. It is suggested that the size of these cubes might correspond to the smallest linear dimension of a house structure—the horizontal thickness of the structural wall, say, 4 in. in usual timber frame construction. Then, by removing from within the matrix all of the space cubes not actually contained in walls, floors, roof and partitions, the house structure is delineated in terms of the cubical module. The basis of standardization of house "units" is thus made available. Mass production, as contemplated in the book, concerns only structural units and not the complete house, so that variety in design is in no way hampered.

The application of this design principle to actual houses is a feature of the book which is a distinct contribution to the cause of prefabricated housing. Readers will also find an interesting appendix, describing and evaluating a large number of the past efforts to design prefabricated houses.

Traffic Planning

Reviewed by John J. Schmitt, Jr.
Chicago, Ill.

STEADYFLOW TRAFFIC SYSTEM—Vol. IX. Harvard City Planning Studies. By Fritz Malcher. Cloth; 7x10 in.; pp. 91. Published by Harvard University Press, Cambridge, Mass. $1.00.

NINTH of the Harvard City Planning Studies, the Steadyflow Traffic System is the first excursion of that series into the field of transportation as related to urban layout.

In city planning it is pointless to discuss the layout of residential areas without taking the business section into direct account. It is futile to consider any portion of such a design without embodying the problem of transportation as an integral part. Further, the attempt to advance a particular scheme of traffic artery fabrication that has a strictly limited field of usability as a basis for city street layout is, at least, rather unreasonable.

The traffic system set forth by Mr. Malcher, who, unfortunately, died before his work was put into print, is far from being the panacea for all traffic ills. That the system has merit cannot be denied, but the range of its application is apparently so narrow that it is doubtful if more than one or two of the steadyflow principles could ever be used in any given area.

Based on the thesis that continuous traffic movement is the ultimate for motorists, city planners, and cops, the steadyflow system is supposed to provide arteries through which an uninterrupted stream of vehicles flows at moderate speed. Stop-and-go signals are treated as if they were buggy-whips.

According to the system the boulevards, or the main stems with the highest traffic concentration, carry through more or less on a straight line. Intersecting streets do not cross the main street, but the cross traffic turns with the main current, strong-arms its way to the opposite curb and turns off at the next outlet. This constant weaving in and out of moving traffic eliminates the need for stopping the main flow unless two cars lose wheels at the same time. When two main arteries intersect the result is a ring-around-a-rosy affair such as every small town has around its court-house square.

It is hardly axiomatic that the traffic light is just a temporary evil or something to jangle the nerves of the impatient motorist. To treat it as such is to ignore the importance of the one def-

inite method of traffic and speed control. Anything similar to the steadyflow system cannot be considered until the motorist wants to trade the stop-light and the attending occasional delay for a catch-as-catch-can proposition that would surely result in plenty of bumper tangling and fender wrinkling.

Surveying

Reviewed by Paul P. Rice
Instructor in Civil Engineering, Lafayette College, Easton, Pa.

ELEMENTARY PLANE SURVEYING — Text and Manual. By Raymond E. Davis. Fabricoid; 5x8 in.; pp. 424; halftones, linecuts and tables. Published by McGraw-Hill Book Co., New York and London. Price $3.00.

THE AUTHOR of this text is also one of the authors of the well-known surveying reference book, "Surveying Theory and Practice" by Davis, Foote, and Rayner. In preparing this work the author has employed essentially the splendid arrangement of subject matter of the 1934 edition of this widely used text, and many of the illustrations, although redrawn, are from that source. The book supersedes the author's "Manual of Surveying for Field and Office," first published in 1915. Desirable features of that manual, particularly with regard to the outlines of field and office exercises and sample notes, are retained.

This treatise is particularly designed to meet an ever increasing demand on the part of surveying teachers for an abbreviated and less expensive text for use in short courses ordinarily given to students in architecture, forestry, landscape architecture and in engineering other than the civil and mining branches. The author has incorporated valuable suggestions and advice received from a number of teachers of such short courses.

The text may be assigned in a one semester course of two recitation hours per week and selected field and office exercises covering major divisions of the subject may be assigned in a one semester course of three hours per week. When used with one of the several excellent texts available on higher surveying, this book will be valuable for those surveying courses primarily offered to civil and mining engineering students.

A feature that will appeal to many instructors is the combination into one book of text, field and office manual, and tables. Following such chapters as require it, are carefully selected numerical problems to illustrate the text. Fifty-one field and office problems or exercises are included, designed to give the student drafting room and field experience. Although not prepared as a "pocket" handbook the book's small size and thickness, comparatively to the usual text, permits it to be carried into the field in an outer coat pocket. Eleven tables are listed including all those required for ordinary surveying work.

The practicing engineer and surveyor also will find this book of value. In logical sequence, good style and with clear cut illustrations are presented all the facts pertaining to 90 per cent of all surveying work, and in half the usual space.

During the past two years a more than ordinary number of new and revised surveying books have been published. "Elementary Plane Surveying" by Davis meets a distinct and long expressed need in spite of other recent new books.

Miscellaneous Notes on Booklets and Reprints

THE SILT THEORY OF FLOW OF WATER, a paper by Radha Kreshna Khanna, assistant engineer, Punjab Irrigation, has been published by Mr. Khanna, Lahore, India.

WHERE THEY GO AND WHAT THEY DO, a report upon the graduates of Purdue University. Published by the Purdue University, Lafayette, Ind.

MORE FACTS ON TECHNOLOGY AND EMPLOYMENT have been published by Machinery and Allied Products Institute, 221 No. LaSalle St., Chicago, Ill., as a sequel to "10 Facts on Technology and Employment."

TERMITES and their relation to fire hazards, National Board of Fire Underwriters, 85 Johns St., New York, N. Y. An eight page pamphlet briefly summarizing the damage done by termites and methods of combating them.

PUBLIC OWNERSHIP, promises and results. An account of the building and operation of the municipal light and power plant at Oberlin, Ohio, prepared and published by Howell Wright, Leader Building, Cleveland, Ohio.

FIRE RESISTING MATERIALS and rules for fire testing are the subject of Meddelande 66, one of a series of pamphlets published by Statens Provningsanstalt, Stockholm, Sweden. Captions for the principal illustrations and a considerable part of the text are printed in English.

THE CARBONIZATION of unhydrated portland cement, Technical Paper No. 19, Building Research, Department of Scientific and Industrial Research (Great Britain), obtainable from the British Library of Information, 270 Madison Ave., New York. Price 35c.

COST INDICES for railroad construction, compiled by the Bureau of Valuation, Interstate Commerce Commission, Washington, D. C., have been brought up to date by the bureau. The figures are published in mimeograph form under the title Railroad Construction Indices.

THE THIEM METHOD for determining permeability of water-bearing materials and its application to the determination of specific yield is the subject of Water Supply Paper 679-A, U. S. Geological Survey. Obtainable from the Superintendent of Documents, Washington, D. C., price 10 cents.

A SERIES OF ARTICLES on the legal difficulties that beset one who undertakes building operations, prepared by Samuel I. Sacks, an engineer and lawyer, originally printed in *The Legal Intelligencer* has been printed in booklet form by *The Legal Intelligencer*, Philadelphia, Pa., under the title "When Your Client Builds."

THE SAN FRANCISCO-OAKLAND BAY BRIDGE is the subject of another "technical description in ordinary language" by E. Cromwell Mensch, 447 Sansome St., San Francisco, Cal. Recently a similar booklet concerning the Golden Gate Bridge was published. The books are notable for their clear schematic drawings.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

A CLASS BOOK OF MAGNETISM AND ELECTRICITY — By H. E. Hadley. Cloth; 5x7½ in.; pp. 512; photographs, diagrams, tables. Published by Macmillan & Co., Ltd., London, and the Macmillan Co., New York. Price $2.50.

A MANUAL OF PHOTO-ELASTICITY FOR ENGINEERS—By L. N. G. Filon. Cloth; 5x7½ in.; pp. 140; linecuts, tables. Published by Cambridge University Press, Cambridge, Mass., and The Macmillan Co., New York. Price $1.50.

CARBON DIOXIDE—By Elton L. Quinn and Charles L. Jones. Cloth; 6x9 in.; pp. 294; photographs, linecuts and tables. Published by Reinhold Publishing Corp., New York. Price $7.50.

EARTHQUAKES — By Nicholas Hunter Heck. Cloth; 6x9 in.; pp. 222; photographs, linecuts. Published by Princeton University Press, Princeton, N. J. Price, $3.50.

INDUSTRIAL DUST—By Philip Drinker and Theodore Hatch. Cloth; 6x9 in.; pp. 316; photographs, charts, tables. Published by McGraw-Hill Book Co., Inc., New York and London. Price $4.00.

THE PROFESSIONAL ENGINEER—By Esther Lucile Brown. Board; 5x8 in.; pp. 86. Published by Russell Sage Foundation, New York. Price 75c.

RAILWAY MAINTENANCE PROBLEMS —By Lt.-Col. H. A. Hull. Cloth; 5¼x8¼ in.; pp. 82; linecuts. Published by The Railway Gazette, London. Price 5 shillings net.

REINFORCED CONCRETE—By Robert A. Caughey. Cloth; 6x9 in.; pp. 292; linecuts and tables. Published by D. Van Nostrand Co., Inc., New York. Price $3.75.

SELBSTTATIGE STAUVORRICHTUNGEN —By Gustav Markowitz. Paper; 7x10 in.; pp. 82; photographs, diagrams, tables. Published by Franckh'sche Verlagshandlung, Stuttgart, Germany. Price

SENSE AND SAFETY ON THE ROAD—By R. B. Stoeckel, M. A. May and R. S. Kirby. Cloth; 5x8 in.; pp. 293; photographs, linecuts, charts. Published by D. Appleton-Century Co., New York. Price $1.50.

STORM RAINFALL OF EASTERN UNITED STATES (Revised)—By the Engineering Staff of the Miami Conservancy District, Ohio. Technical Reports, Part V. Paper; 6x9 in.; pp. 352; charts, maps and tables. Published at Dayton, Ohio.

TEXAS ALMANAC AND STATE INDUSTRIAL GUIDE SINCE 1857—Texas Centenial Edition. Paper; 6x8 in.; pp. 512; photographs, diagrams, tables, maps. Published by the Dallas News, Dallas, Tex. Price 50c.; 65c. postpaid.

TASCHENBUCH DER STADT-ENTWASSERUNG—By K. Imhoff. Paper; 4½x7 in.; pp. 195; tables and diagrams. Published by R. Oldenbourg, Munich and Berlin.

Letters to the Editor

Winter Damage to Roads in South

Sir—I am greatly obliged for the opportunity afforded me to discuss the economic questions involved in the survey of winter damage to highways as presented in recent issues of *Engineering News-Record* (*ENR*, June 4, p. 801, and June 11, p. 842).

Since the survey is stated as wholly factual and purposely avoids deductions or conclusions, it follows that subsequent practical discussion by readers is the most helpful method of deriving value from the survey, and in that spirit I shall endeavor to make my comment constructive rather than critical. The factual presentation however was extended to deduction in the report of S. T. Henry on the Southeastern States (June 4, p. 802), where Mr. Henry said "black top construction is open to much question in the Southeast." I trust therefore you will permit a few words of comment to the end that Mr. Henry's observation may not unwittingly instil doubt in the minds of the many engineers who build "black top."

The term "black top" is meaningless as descriptive of a type of surface and is loosely used to describe every black highway surface from a road oil or tarred earth road to a Fifth Avenue type of sheet asphalt. I can only infer that Mr. Henry really meant surface treated types, as my information from the state engineers of North Carolina, Georgia and Tennessee is that winter did negligible damage to hot mix pavements, although the thin portland cement concrete bases in North Carolina did suffer to an appreciable extent.

State Highway Engineer Newton of Georgia reports:

> The damage to hot mix in Portland cement concrete bases was negligible. The same is true of the sand asphalt mixes. The damage to hot mix on stone and gravel bases was negligible.

State Highway Engineer Goetz of Tennessee reports:

> Our damage was confined almost entirely to mixed-in-place surfaces. We had no failures on hot-mix, on Portland cement concrete base, nor on hot-mix on stone base or gravel base. No failures on sheet asphalt or penetration macadam. The slight damage done to high type pavement has been remedied, and the damage to low cost types is being remedied as rapidly as possible and should be completed within a short time.

State Highway Engineer Baise of North Carolina reports:

> In the case of some of our asphalt roads with concrete base, we had rather heavy damage during the past winter due to the base failing under the heavy traffic with the severe weather conditions. All our concrete bases on which asphalt tops were placed several years ago were constructed with a 5" depth of lean concrete and we find that under the large amount of heavy traffic and with the adverse weather conditions these bases were not adequate to withstand the punishment which they received. For the most part our roads constructed with concrete bases and asphalt tops stood up very well where the bases were firm and uniform but on the other hand, we had several miles of this type which suffered material damage where the subgrade was not ideal.

To emphasize further the behavior of "black top" pavements, I call attention to the fact that the entire winter damage to the state system of Massachusetts, principally black top, was only $40,000.

Establishing therefore as a premise that winter destruction struck most heavily at the low cost types this economic query becomes most pertinent—"Is the low cost road a real economy?" *Engineering News-Record* itself raises an implied question in the editorial of June 11th, but this is too grave a question to settle by a drum head court martial which often condemns the accused on superficial evidence. The low cost road is and always will be absolutely indispensable whether we like it or not since without these dustless mudless surfaces we revert to wholly inadequate mileages of pavements and a return to the bondage of mud. Who will contend that we can afford to build $25,000 a mile roads exclusively and still even remotely serve traffic needs?

Nor does it follow that because of failure in an unprecedentedly severe winter the low cost road is more costly or even as costly as a pavement. State Engineer Baise of North Carolina places the cost of restoring the 4,000 miles of low cost roads on the state system at $1,500,000, an average of $375 per mile.

Now the interest alone on a mile of $25,000 pavement at 4½ per cent is $1,125 a year, which affords a margin of $750 to the low cost road for interest. Moreover, last winter was the worst in history. We don't build normally for that sort of test.

After all, the winter damage was not devoid of helpful hints. In the first place it probably checked decisively the trend to "snitching" maintenance money for other purposes. Note the following from State Engineer Newton of Georgia:

> Some of the projects involved were ready for retreatment last fall and had we been able to get to them it is undoubtedly true that the damage would have been considerably less.

and from Mr. Baise of North Carolina:

> We had many other surface treated roads which failed due to lack of proper maintenance. The budget of this Commission was materially reduced for the biennium 1934 and 1935 due to the general conditions throughout the country at that time and as a result of the small amount of funds which we had for maintenance purposes. We were unable to retreat many of our roads.

In the second place, that the design of the surface treated roads in North Carolina, where damage was heaviest, had much to do with failure is clearly shown by Mr. Baise's description and it is entirely unlikely that the splendid work which Mr. Baise is now doing will fail to render these low cost roads far more resistant to damage. Mr. Baise said:

> The damage on this type of construction was, of course, due to the most unusual winter we have had in this section for many years. The base on many of our surface treated roads was constructed several years ago to be used as untreated topsoil, sand clay or gravel roads and as a result an excess amount of clay in many cases was used in the material which, of course, brought the water up from the subgrade through capillarity and under the extreme weather conditions froze and pushed up the pavement.

This matter of clay content is of the greatest importance, and careful laboratory analyses always should be made to provide for necessary adjustments in proportion, particularly where existing non-bituminous surfaces are to be treated for the first time.

The winter has shown further that there is a certain critical thickness for low cost surfaces, and that while in most instances this is of moderate amount, it is yet measurable. For a number of years the ground water level was below normal and in some instances surfaces had been placed upon the bare ground without any base whatever. From the great variety of these designs, it will be now possible to accurately separate the good from the inadequate.

Whether or not a state system should include a large mileage of modern low cost roads is a basically important question, particularly in the light of winter damage. The ablest and fairest analysis of this question I have ever read is presented in a brief recently issued by the State Highway Commission of Virginia, and I quote a few paragraphs from the brief because I believe the text will be enlightening and helpful to every reader.

> There has been constructed on the primary system 3,500 miles of durable type surfacing and approximately 5,000 miles of oiled and bituminous surfaced roads.
>
> It costs approximately $25,000 per mile for the durable type and about $2,500 for the oil treated. If the Commission had surfaced the 5,000 miles of oiled roads with a more durable surface it would have cost

123 million, whereas there has only been expended twelve and one-half million for the oiled roads. This would make a difference of one-hundred-twelve and one-half (112½) million dollars which the Commission did not have. Interest on the 112½ million at 4% would amount to 4½ million annually.

It costs about $200 more per mile per year to maintain an oiled road than a more durable type and this excess cost on 5,000 miles would be one million, leaving three and one-half million interest charges that would have been necessary if a more durable type had been used. If the more durable type had been constructed only 500 miles could have been built and there would be only 4,000 miles of surfaced roads in the highway system, whereas we have 8,500 miles that can be traveled in comfort without mud or dust 365 days of the year.

During the past fourteen years the oiled surface roads have only broken up once or twice and can be restored at not a great cost.

The figures given by the Bureau of Public Roads, that there is saved approximately 3c per vehicle per mile in traveling over surfaced roads rather than mud and dusty roads, show a large savings to the traveling public has been affected by the plan used.

There is traveled in the State approximately four and one-half (4½) billion vehicle miles per year, 70% of which is outside of the cities and about one billion traveled on the 5,000 miles of oiled roads, making a saving of thirty million dollars per year by oiling the 5,000 miles. This, plus the three and one-half (3½) million interest charge would make an annual saving of 33½ million dollars to the traveling public.

The plan adopted also had the advantage of giving a surfaced road to every incorporated town, county seat and connecting every city, as well as giving tourist access to the many points of historical and other interests in the State. This trade has been estimated at a value of between seventy and eighty million dollars annually.

Summing up this discussion I submit that (a) the damage was largely a low cost road phenomenon; (b) that it was due in substantial measure to reduction in maintenance appropriations; (c) that valuable lessons have been learned in foundation design both as to critical thickness and the harmful effect of excessive capillary clay content; (d) that low cost roads are a necessity; (e) that they are economical even in the face of unprecedented conditions.

I trust you will believe that my discussion is a tribute to the excellence of the factual survey and not in any sense as protest against the findings.

J. E. PENNYBACKER
Managing Director,
Asphalt Institute.

New York, N. Y.
June 29, 1936.

Long Timber Trusses

Sir—In an interesting article published in *ENR*, issue of April 2, under the title "Timber Stiffening Trusses for Suspension Bridge of 345-ft. Span" by Wm. D. Smith and Rudolph K. Krausse, it is stated that the span of 344 ft. 8 in. of such trusses is believed to be a record span for an all-timber stiffening truss.

In this connection I have thought convenient to point out the circumstance that in this country (Venezuela) the Public Works Department has built suspension bridges with timber stiffening trusses of spans longer than 344 ft. 8 in., such as one over the Uribante River in the State of Táchira, 162 meters (531 ft.) span and the one on the Acarigua River, in the State of Portuguesa, with 120 meters (394 ft.) span. Descriptions of both bridges can be found in the Annual Reports of this Department to Congress for the years 1922 and 1933 respectively.

JOSÉ SANABRIA
Engineer, Bridge Division.
Department of Public Works, Venezuela.

Caracas, Venezuela.
Aug. 8, 1936.

Use of Safety Nets

Sir—In *ENR* of July 30, p. 174, you discuss a safety net under the Golden Gate bridge, and say something about its being "inaugurated" on this job.

The South African Railways used a safety net below their Zambesi River bridge near Victoria Falls during construction, about 1915. No doubt you can find reference to it in contemporary technical publications. I myself read about it at that time in the "Scientific American," since in those days I had not graduated to the more technical but perhaps more locally-minded engineering publications.

JAMES WILSON

Flushing, N. Y.
Aug. 19, 1936.

Early Use of Soil Mechanics In Foundation Design

Sir—It may be of interest to readers of *Engineering News-Record* to know that probably the first structure to have its foundations designed in accord with modern principles of soil mechanics is the U. S. Naval Hospital at Philadelphia, Pa.

The building was to be 15 stories high in the main section, with 5 story wings. When the design was started, in 1932, by the Bureau of Yards and Docks, of the Navy Department, test piles were driven and the ordinary loading tests made. The results indicated an unsatisfactory foundation condition; this condition was confirmed by test borings and by records of settlement of heavy structures in the vicinity. The borings indicated that a 50-ft. stratum of sand and gravel fill overlaid alternating strata of clay and sand.

To obtain information as to the probable settlement of the building, undisturbed samples of the clay strata were obtained and tested in the laboratory of the Bureau of Public Roads, Department of Agriculture. From the data obtained in these tests and from the calculated foundation loads, stress contours were drawn for each clay stratum, and from these, settlement contour maps were prepared for the site of the building. Three types of foundation were studied in this way: all pile, all caisson, and caissons under the main building with piles under the wings. This last type was adopted.

It was recognized that differential settlement was bound to take place, since the piles would not be driven into the first clay stratum, whereas the caissons were to be sunk through this stratum and rest on the sand below it. Special slip joints were designed to be placed between the central main building and the wings, which permitted relative vertical movement without a sharp break in floor levels.

This building has been completed and occupied for nearly two years. Settlement readings are made periodically, and, although the amount of settlement is not quite as much as calculated for the time elapsed, there is little difference between calculated and actual settlement. The actual settlement contours correspond in shape quite accurately with those calculated while designing the foundations. The slip joints have proved effective, and no settlement cracks in the plaster have occurred.

The calculation of settlement contours and the practical design of foundations on the basis of settlements calculated therefrom is believed to have been first carried out by the officers of the Corps of Civil Engineers and the Bureau of Yards and Docks of the Navy.

WALTER H. ALLEN
Captain (CEC) U. S. N.

Washington, D. C.
August 3, 1936.

Puzzolana Cements

Sir—Robert A Kinzie, Jr., fears (*ENR*, July 9, 1936, p. 61) that my quotation from M. Periani's paper may create a misunderstanding.

A rereading of my quotation and its context (*ENR*, Feb. 12, 1936, p. 257) will show the only understanding warranted is that the oft-referred-to European use of puzzolanas has not been wholly successful.

If error and misunderstanding derive from this interpretation of the quotation criticism is in order but otherwise it would appear to be groundless.

BAILEY TREMPER
Materials Engineer,
Department of Highways

Olympia, Wash.
July 17, 1936.

A Complete Incinerator

Sir—I have read with much interest the articles entitled "Basic Principles of Incineration" by Edward B. Very that appeared in the May 14 and 21 issues of *Engineering News-Record*.

In his concluding paragraph, Mr. Very expresses a doubt of the likelihood of finding an incinerator installation in which are present all the fundamental features he listed as necessary for the basic design of a plant. In the new incinerator plant erected by the New York City Department of Sanitation, in Flushing, all those features recommended by him are included in the design, with the exception of automatic secondary air control. With our system of operation it was not regarded as necessary to include an automatic device, but a manually operated secondary air control has been provided.

G. C. HOLBROOK
Mechanical Engineer

New York City,
July 24, 1936.

ENGINEERING NEWS-RECORD

Volume 117, No. 9 Copyright, 1936, by McGraw-Hill Publishing Company, Inc.

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, C. S. Hill, H. W. Richardson, E. J. Cleary

Editorial and Publishing Offices at 330 West 42d Street, New York

August 27, 1936

Transportation Comes High

ONE OF THE penalties mankind pays for its big-city civilization is the high cost of transportation. This realization is forcibly brought to mind in reviewing the bids submitted for the construction of the second section of the Sixth Ave. subway in New York City. The bids indicate that for a six-block length of four-track subway the structure alone will cost about $8,000,000, an all-time high for a corresponding length of land line in subway history. Later contracts for track, signals and station finish will raise the cost of the section to $10,000,000; and rolling stock of course will add a further item. As this section, extending from 34th St. to 40th St., is only 1,787 ft. or one-third of a mile long, the cost is at a rate of $30 millions per mile. This is something of a record in expensive railroad construction. There is no doubt that the new line is needed, for the four parallel subway routes are already taxed to capacity, but the fact remains that urban rapid transit comes high, and that until practical ways are found to make each track carry more traffic there is little chance that these costs will come down.

Fortunes for Links

SURPASSING EVEN the scale of costliness of the Sixth Avenue subway, another current example further emphasizes the fact that key links of modern transportation are apt to cost great fortunes. The East River vehicle tunnel that is to connect New York's Queens district with midtown Manhattan, a link of little more than a mile between terminal plaza exits, is to cost $58 millions, or nearly a million per 100-ft. station. Forming a street link only, this tunnel is made sensational not only by its cost but also by the fact that a bridge projected for equivalent service was estimated to cost only half as much. It does not stand alone, however, as proof that congestion at keypoints of modern transportation network is leading us into enormous expenditures to build major traffic links. How much more the cost of these links is likely to increase as time goes on it would be idle to conjecture; the present trend, at all events, is toward ever higher costs—usually because of compelling physical conditions, but sometimes because of legislative mandate or for sentimental reasons. To counteract this trend and keep costs from increasing further will justify very careful advance study of traffic link problems, to see whether a solution cannot be found that will combine efficiency and economy.

Wisconsin Cleans Up

UNDER A 10-YEAR PROGRAM of stream pollution abatement consistently carried out step by step, Wisconsin has gone a long way toward restoring its streams to a reasonably clean condition. Commendable cooperation of government and industrial officials to that end has been no small factor in making the program possible. The procedure adopted involved taking first those streams whose need for pollution abatement was greatest and hammering away at each offending municipality and industrial plant on the watershed until purification works were installed. During the period of the drive 81 new or reconstructed sewage treatment plants have been provided, and when the present construction is completed 73 per cent of the state's population will have facilities at least for primary treatment. The details of the accomplishment, noted elsewhere in this issue, will be looked upon with envious eyes by many other states. The urgent need for similar clean-up campaigning elsewhere is witnessed by the foul condition of innumerable brooks and rivers that have been converted into open sewers and that are a liability to the countryside they once beautified.

A Promising Conference

CALLED TOGETHER for the second year, bituminous road-builders of the western states will meet early next month to discuss construction and upkeep practices for light- and medium-surfaced asphalt roads. The meeting this year, following the conference a year ago on fundamentals of bituminous road design, promises to write an authoritative second chapter in the technical discussion of a road type that the plateau and mountain states of the west have made particularly their own. With enormous distances, light traffic and moderate funds, these states have used their adaptable natural soils to produce remarkable road-mix surfaces with their Wyoming, Texas and California asphalts. For this reason the coming conference on practice, is regional in scope, and although called together and sponsored by the Montana state highway department it will assemble speakers and reports from the whole range of mountain and coast states, together with some from the east and south. The conference promises to be productive of opinion and experience on the secondary types of bituminous roads that will exert a wide influence on practice.

Works Campaign Ends

WHAT WAS LEFT of the movement so grandly conceived three years ago to restart the machinery of industry and make jobs for idle producers by a vigorous public-works campaign has come to an inglorious end through the government's action in limiting further public-works aid to the amount of relief labor that can be given jobs. This action, in degrading the PWA to an appendage of the WPA relief system, discards the surviving remnant of economic purpose and real employment in favor of social-worker policies and makeshift job-giving. It is true that the public-works movement never really had a chance, for vacillating governmental policy paralyzed it from the start. Yet the PWA did manage to operate, and did accomplish a large amount of good, both for the nation's business and for the hard-pressed local governments. Now that the PWA era is over the local governments must look to their own efforts; maintenance and improvement of city, county and state once more become dependent on the initiative of their citizens and officials. The city in particular, if it hopes to reestablish itself as a desirable place in which to live by repairing rundown facilities and catching up with obsolescence, will need to embark promptly on foresighted planning—physical as well as financial—and a consistent program of execution. The growth that has already begun will not long thrive in the presence of deterioration, decay and failure to modernize.

Express Roads for Express Traffic

IT HAS BEEN WELL SAID that our main highways are merely connected neighborhood roads. Even though some main roads follow the course of early long distance trails, most of our highway trunks are patchworks of roads built originally to serve local purposes alone. Few if any of them measure up to the requirements of long-distance transportation service of which modern motor vehicles are capable.

We have developed the vehicles to carry express traffic, and we actually carry on an increasing volume of such traffic, but we do not have an express road system. It is in respect to this adaptation of road to vehicle and traffic that the German express road system described in this issue is noteworthy. As in the case of our scattered short lengths of parkways and superhighways, or as in the case of Italy's *autostrade*, the express arterials that Germany is now building do not consider neighborhood road service except as express traffic originates or ends locally; in fact neighborhood road service is made impossible by physical separation of the road from the adjoining private property. Traffic on the road therefore is unobstructed by local-service movements and can proceed with the directness and even progress of a main-line railway express train.

The idea of express roads completely separated from the lines of connected neighborhood roads is not new to our highway thinking. On the contrary, it has been discussed for years, its future necessity has been taken for granted, and a dozen or more short sections have been built—for terminal service or other special needs. But no large-scale embodiment of the idea has yet found place in our highway construction. The German express-road program therefore brings us the first practical embodiment of an idea that beyond question will control a great deal of our future highway planning and construction.

First of the controlling considerations of express road construction is that the road must be considered in conjunction with the vehicle that travels it. Our present-day roads, carrying automobiles and trucks able to travel at great speed and with high endurance over long distances, and actually performing a large amount of long-haul transport, are heavily handicapped by having to serve the neighborhood function of short-distance transportation. The traveler can, it is true, cover a long distance continuously, but only under difficulties that discourage any serious thought of express transportation. Through or express service calls for complete revision of the plan of the road, general as well as detail. It is by no means a mere matter of changing the use of the road. Either the present roads must be rebuilt, or a new system of express roads must be provided.

In general it is out of the question to transform these existing roads to express roads. The service of which the highway and the motor vehicle are capable can be made an actuality only by supplementing the present neighborhood road system with a separate network of through highways. The aggregate mileage of such express roads need not be great, but the system must be designed in comprehensive manner; their planning must not be haphazard.

Unfortunately, we still lack full knowledge of express road construction and operation. We cannot be sure even as to alignment, width, and quality of road structure, nor have we as yet developed safe and adequate methods of operation; nevertheless the express road is coming and is bound to dominate our transportation system, for without it the possibilities of highway automotive transit cannot be realized. The missing knowledge must be obtained before the building of an express-road system can be undertaken.

The survey of highway facilities and transport now being made by the Bureau of Public Roads in conjunction with state highway departments is a necessary first step in the development of express-road fundamentals. All the essentials of plan, structure and operation required for the smooth and safe movement of traffic in varying volume remain to be determined, among them right-of-way and travel widths, location details, sight distances, access road control, signaling and lighting.

Such sections of express road as we have today are insufficient to give the needed information; the main body of facts is still lacking, and the determination of these facts through far-reaching and intensive study is a necessary preliminary to actual beginning on the express road network that soon must be built. Though European express roads may in the meantime supply useful precedent or warning, according to their service, performance, the planning of the American express road system is bound to rest essentially on our own traffic experience. It is one of the principal tasks of the highway engineering profession to transform this experience into principles and conclusions adequate for the planning of an efficient network of express roads.

Deflating City Services

IN NEW ENGLAND recently a court's recommendation dramatized a problem that municipal engineers of industrial cities must face occasionally. The problem—contraction of municipal services as a result of an industry closing its doors or moving away—might become common under general industrial decentralization or in a period of great industrial advance and inventiveness, when products and factories might suddenly become obsolete.

The case involves Manchester, N. H., and the Amoskeag Manufacturing Co., erstwhile textile giant, whose liquidation has been recommended by a special master in federal court proceedings. Ailing since New England textile business started its trek south, Amoskeag fought valiantly to remain on its feet, but profits remained inaccessible. Its doors are to be closed and its employees, once numbering 18,000, are withdrawn as consumers of municipal services—at least as paying consumers—until some other industry attracted by the idle plant and available water power at Manchester sets up shop and takes them in. In the meantime a reorientation of the city's economic life may be required. Business will be curtailed, tax receipts will be lower. Many residences will be abandoned.

Whole sections of a city might be depopulated by changes of such magnitude. In these circumstances, what should a city engineer do with his water plant, his sewerage and his street system? His problem is quite the reverse of the more usual one which attends city expansion, either industrial or residential. Should excess plant be abandoned or maintained against the possibility of a future regrowth? On what streets should he permit the grass to grow? These and other questions must be answered by Manchester. It still has boots and shoes, paper and pulp to keep it alive, but Amoskeag's passing is a blow that will be sorely felt. Other industrial cities may perhaps see in Manchester's experience something significant and worth thinking about.

CURRENT NEWS

Vehicular Tunnel Started Under Thames Estuary

First contracts have been let on a vehicular tunnel under the Thames Estuary between Dartford and Purfleet. The completed tunnel, with approaches, will be somewhat more than a mile in length and is estimated to cost about $16,000,000. At present there is no means of crossing the Thames by bridge or tunnel below Blackwall Tunnel, which is 35 miles from the mouth of the Thames Estuary. The new tunnel is about 12 miles below Blackwall Tunnel.

The present contract is for the construction of the 12-ft. pilot tunnel, about 2,700 ft. long; two 18 ft. ventilation shafts; and, at the foot of each shaft, a shield chamber, 35 ft. in inside diameter, to be used as starting point for the construction of the main tunnel. The cost of this work will be about $1,500,000. The contract was let to Charles Brand and Son.

On the north side of the Thames, the tunnel approaches will connect with the Purfleet Grays Road and the London-Southend highway. On the south side the approaches will connect with the Dartford-Southend bypass and the London-Folkstone and London-Hastings road.

—⟡—

Rumors of Bad Condition Of Washington Bridge Untrue

Engineering experts whose attention has been attracted to reports that the Francis Scott Key Bridge over the Potomac River, from the foot of 34th St., District of Columbia, to Rosslyn, Va., is subsiding, and in danger of collapse, are united in calling the reports absurd. Built under the direction of the Corps of Engineers the Key bridge was opened for traffic Jan. 17, 1923. It consists of a series of seven open spandrel concrete arches and concrete retaining wall approaches and has stood up remarkably well even under unusual conditions, as instanced last spring when the bridge was subjected to the stresses of the highest floods on record.

During its construction the engineers discovered that at the Virginia approach, resting on concrete piles driven down to what had been thought was bed rock, there were evidences of subsidence. Test shafts were sunk at once and it was found that the piles rested upon boulders which had started to revolve under pressure. Added shafts were then sunk to bedrock, 20 to 24 ft. below mean low water, and a system of tie beams introduced, to brace the piers upon which the span rests. Since that time there has been no further trouble with the bridge.

The approach on the Virginia side, however, rests on an 80-ft. fill and the natural contraction of that ground has caused minor cracks in the parapets as well as minor rolls and breaks in the roadway. This was expected by the engineers and is nothing that can not be taken care of by ordinary methods of repair.

Injunction Sought Against TVA

Temporary injunction sought while application for permanent injunction, made in June, awaits decision

THE nineteen power companies operating in the Tennessee Valley which, last June, entered suit in the U. S. District Court at Birmingham seeking a permanent injunction against operation of the Tennessee Valley Authority on the ground that its actions were unconstitutional (*ENR*, June 4, 1936, p. 826) have filed a rider to that suit seeking a temporary injunction against the TVA pending disposal of the request for a permanent injunction.

The request states that the TVA has "not only continued but greatly increased their activity in carrying into execution their power program, with the obvious purpose and intent of advancing the power program as far as possible before this cause can be heard." The companies state that the TVA is proceeding with the construction of a complete network of transmission and distribution lines and that the TVA is appropriating the customers and markets of these utilities and interfering with their present business relationships. They state that the TVA now has, or is soliciting, contracts to provide power for 22 cities in Tennessee, 11 in Mississippi, 7 in Alabama, and 1 in Georgia.

The injunction would, if granted, restrain the TVA from building transmission lines, soliciting contracts to provide any new transmission lines or distribution systems, or from carrying on any sort of promotion campaign for public power. It is not sought to restrain continuation of such services as the TVA was rendering at the time the motion was filed. There is some doubt whether the injunction requested would stop work on hydro-electric dams now under construction.

The court has not yet taken any action on this motion.

Exception Announced To Relief Labor Ruling

President Roosevelt has modified his ruling that projects on the new PWA program must use 100 per cent relief labor. The new ruling authorizes 45 per cent grants to municipalities which have already voted a bond issue on pending applications. The requirement of 100 per cent relief labor still holds on all other projects.

PWA estimates that the exempted class will include less than one-third of the projects under the $200,000,000 program.

The President announced approval of a few projects under this ruling.

Forty-three Million H.P. In U. S. Rivers

The United States Geological Survey has prepared an estimate of the potential water power resources of this country. The computations have been made on several different bases. Assuming 70 per cent efficiency in development of power, and taking account of all possible future storage for the regulation of stream flow, the survey estimates that there would be available 42,753,000 hp. 90 per cent of the time; 50 per cent of the time 57,184,000 hp. would be available.

In order to conform to tentative international standards, the survey has also prepared estimates based on an assumption of 100 per cent efficiency of power development, but not taking account of any storage except that already existing. This estimate is given in kilowatts. On this basis there would be available 95 per cent of the time 25,045,000 kw.; 50 per cent of the time there would be 53,863,000 kw. available. An estimate has also been prepared based on mean annual flow, which would give 82,180,000 kw.

—⟡—

Final Plans Made For Bituminous Conference

Full and final plans have been made for the second Montana Bituminous Conference, to be held under the auspices of the Montana state highway department at Many Glacier Hotel, Glacier National Park, on Sept. 8, 9 and 10. The program will be largely devoted to papers and discussions on four main subjects: A review of analytical engineering methods and research as applied to bituminous road construction; developments and fundamentals of successful bituminous practice; developments in practical design and construction of bituminous surfaces; and maintenance of bituminous surfaces. The last three subjects will be presented as an analysis and review of seven papers prepared on each subject by as many authors. The first subject will be covered in a single paper presented by Prof. L. D. Conkling, Montana State College. Each of the individual papers will be available to the delegates, as will the summaries and reviews. After each presentation there will be a technical discussion conducted by a round-table conference board.

Delegates traveling by car and train will be met at the Glacier Park station by representatives of the Montana highway commission who will conduct them to the hotel, 50 miles away. An attendance of 500 is expected, including delegates from nearly every state in the union. The West will be strongly represented. D. A. McKinnon, state highway engineer of Montana, is general chairman of the meeting, and E. B. Donahue, assistant chief engineer, is in charge of the program.

MANHATTAN APPROACH TO NEW YORK'S NEW MIDTOWN TUNNEL

Construction of the depressed entrance plaza at the Manhattan end of the Midtown tunnel under the Hudson River in New York is nearing completion with installation of cantilever retaining walls. The plaza, dug out of solid rock, will be served by ramps leading from 36th and 42d Sts. This view is looking west between 38th and 39th Sts., with the portal of the 800-ft. cut-and-cover entrance to the tunnel in the background. The Cornell Contracting Corp. is contractor for the Port of New York Authority.

Pollution Treaty Proposed In Ohio River Basin

Governor Davy of Ohio has written to the governors of seven states in the Ohio River drainage basin suggesting that a commission be formed to draft a treaty, among as many as possible of the states concerned, for the abatement of sewage pollution in the Ohio River. The treaty would be made under the provisions of an act of the last Congress authorizing treaties between states for the prevention of river pollution.

The governor suggested that each state appoint three representatives, one representing health and conservation interests, one to represent commerce and industry, and one to represent the public at large. The governor suggested that it might be well to set up advisory councils in each state including representation from any special interests desiring to be heard.

The states invited are New York, Pennsylvania, West Virginia, Kentucky, Indiana, Illinois and Tennessee.

San Francisco Water Sales Show Large Annual Profit

Figures for the year ending June, 1936, show total revenue from water sales by the San Francisco Water Department of $6,521,561. After paying all operating and other expenses, the net profit was $2,422,982. In figuring operating expense, it was pointed out that water delivered for city uses (for which no charge is made) offsets taxes that would have been collected by the city from a private water company.

The bond issue with which the city purchased Spring Valley Water Co. properties some years ago was for $41,000,000. It has been the custom to reduce this by about $1,000,000 each year from net profits; this plan was followed this year, bringing the remaining portion of the original bond issue down to $35,000,000. Total value of the water department property now is given as $63,745,819. Water rates were reduced 10 per cent in December, 1934, and a further reduction, primarily affecting industrial users and others who purchase in large quantity, is now under consideration.

University Offers Course For Plant Operators

A three-day course for operators of water-works and sewage disposal plants will be offered on September 9, 10 and 11 at the College of Engineering of the University of Maryland, College Park, Md.; the course is offered in cooperation with the Maryland-Delaware Water & Sewage Association and the Maryland State Department of Health.

The course will include lectures on the basic principles, maintenance and operation of water purification plants; on construction and operation of wells; on the nature and operation of pumps and meters; on applications of chemistry to purification plant operations; on the application of bacteriology to plant operation; and on the operation of distribution systems. There will also be lectures on sewage treatment processes and on the construction and maintenance of sewers and sewage plants.

The course is restricted to plant operators, their assistants, and others connected with water purification or sewage disposal.

Effect of Wells for Air Conditioning

Geologic Survey expresses fears that increased use of air conditioning may lower groundwater levels

A RECENT memorandum sent by O. E. Meinzer, head of the groundwater division of the U. S. Geological Survey, to the members of the groundwater staff expresses a fear that the rapid increase in the use of air conditioning and the common practice of obtaining large quantities of cooling water from wells may cause a serious lowering of the groundwater levels near large cities.

The memorandum requests the members of the staff to report any evidence of such action occuring. Mr. Meinzer points out, however, that there are almost no funds available for studies, sufficiently extended to be valuable, of groundwater levels. Federal money is provided only to the extent of matching any funds provided by the states or municipalities. Appreciation of the need for such studies, the memorandum states, has not been sufficiently widespread to provide a broad foundation of facts on the behavior of groundwater.

Some studies underway

The groundwater division is now making a study of conditions in the District of Columbia. Programs of observations are also being carried on in Houston, Texas; Atlantic City, Camden, and Perth Amboy, New Jersey; and in Long Island. The Geological Survey feels, however, that information should be collected in many other cities and, also, at places remote from centers of population, where the natural fluctuations of the water table can be studied.

Road Builders Meeting and Show To Be Held in New Orleans

The American Road Builders' Association will hold its annual convention and exhibit at New Orleans during the week of Jan. 11, Charles M. Upham, engineer-director of the association, has announced. Discussion of methods of carrying out the federal-aid program on secondary and farm-to-market roads will feature the convention. Highway safety is another subject to which major attention will be given.

Chevalier urges broad program

Commenting on the forthcoming convention Willard T. Chevalier, president of the association, said:

"The 1936 convention and road show of the American Road Builders' Association, held in Cleveland last year, demonstrated that members of the highway industry and profession are in a highly receptive attitude toward all policies that will effect economies and stability in the road building.

"The New Orleans convention must supply all of the information that road builders desire in connection with highway transportation, financing, engineering, construction, and maintenance. Also, it is absolutely necessary that the convention serve as a clearing house for the very latest information on highway safety and other allied subject that are an integral part of highway transportation."

The Drought to Date

A summary of reports on streamflow, ground water and water supply in drought areas by the district engineers of the Geologic Survey

SOURCES of commercial and domestic water supplies in some areas are lower than at any time since the drought, with more than fifty villages in North Dakota hauling water, the Mississippi River flow continuing to decrease, and the Genessee River in New York recording the lowest flow in history, the Geological Survey reports.

Benefits from scattered and relatively light rains in the past few weeks have been offset by the prolonged heat which continues to blanket the country.

In North Dakota, word received from 254 villages stated that 54 villages are hauling water for domestic use, and 65 villages, or approximately 25 per cent, have an inadequate supply.

The Mississippi River at St. Louis had a flow of 45,000 second-feet, a drop of 1,700 second-feet since the middle of August.

In New York the flow of the Genessee River at St. Helena had dropped to 49 second-feet, the lowest ever recorded during the 29 years of record at the Geological Survey station, and two second-feet lower than the previous low in 1934.

In the states of Iowa, Minnesota, Missouri, Montana, Nebraska, Ohio, Oklahoma, and Wyoming commercial and domestic water supplies are almost as low or lower than during the corresponding period of the severe drought two years ago, and, in parts of Iowa and in North and South Dakota, shortages are very acute. Recent rains have improved supply conditions in some sections of the drought area.

A general summary, arranged alphabetically by states, of all the reports on water supply in the drought area received from the geologic survey district engineers follows:

Arkansas: Stream flows have held up, remaining well above the low levels of 1934. Ground water levels, on the other hand, have reached record lows, and in many sections, where the supply is from wells, water is scarce.

Illinois: Although rainfall has been less than 60 per cent of normal since April, there has been no serious shortage of municipal or industrial water supply. Stream flows held above 1934 levels until the middle of August, when they dropped below 1934.

Indiana: There were no serious deficiencies in rainfall before June. Stream flows have decreased steadily, dropping below the 1934 figures late in July; they are now well below the flows for the same date in 1934.

Although there have been no serious shortages of municipal water supply, restrictions on water use and hauling of water prevail in many parts of the state.

Iowa: Until recently, conditions have not been very severe. Stream flows have held, and still hold, above 1934 levels. Ground water levels are well above the levels in 1934. Some shortages of farm and municipal water supply have developed during August.

Kansas: Although there was very little rainfall during June and July, improvments in the water supply systems, made after the 1934 drought, have prevented any water shortages. Stream flows are generally much higher than in 1934, and ground water levels are about a foot higher than in that year. Rains early in August materially improved the situation.

Kentucky: Heavier than normal rains in the early part of the year have prevented the drought situation from becoming serious. Although there have been some restrictions on water use, stream flows and ground water levels have held up well.

HEAVY COFFERDAM FOR CHICAGO SEWER TUNNEL

An unusually heavy sheet-steel pile cofferdam has been built for the Southwest Side interceptor sewer tunnel crossing of the Chicago Drainage Canal in Chicago. The deep coffer, of arch-web sheeting, is braced by transverse truss frames, hanging from the top steel wale, and the end posts of the trusses bear against intermediate steel wales. The truss system was designed to carry a truck and crane runway from which excavation and concrete work was carried on. This view shows excavation for the connection between the underwater box section and the land tunnel section, near the new Southwest Side sewage treatment works. The river crossing is being built by the Herlihy-Mid Continent Co., of Chicago, for the Chicago Sanitary District.

Michigan: Ground water levels are dropping, and are now lower than at any time in the past two years.

Minnesota: Stream flows are lower than in 1934, and there is considerable shortage in municipal water supply, especially in the Red River Valley.

Missouri: Until recently there has been no water shortage. In the middle of August signs of shortage began to occur in the northern part of the state where surface waters are used. The southern part of the state, obtaining water from deep wells, has experienced no shortage.

Montana: There has been severe shortage of water for irrigation and domestic farm use; restrictions have been placed on the use of municipal water supplies. Except for the Yellowstone and Missouri Rivers, which derive their supply from the well-watered mountainous areas to the west, stream flows are lower than in 1934.

Nebraska: Stream flows are about the same as in 1934. Ground water levels in many parts of the state are lower than in 1934, and, since many cities depend upon wells for supply, there has been considerable shortage of municipal water.

New York: Except for a temporary rise during the first week in August, stream flows have been dropping steadily, in some cases to record low figures. Most municipal water supplies are protected by large storage reservoirs, and there has been no shortage; mills dependent on the use of water power are, however, experiencing difficulty.

North Dakota: With stream flows lower than at the same time in 1934, and with ground water very low, there has been widespread shortage of water for municipal supplies, and practically no water is available for irrigation. About 25 per cent of the villages in the state are hauling water.

Ohio: Rainfall in Ohio has been much better than in 1934. Although many farms are short of water, there have been no serious municipal shortages. Such restrictions on water use as have been applied are due to increased use arising from drought conditions rather than from deficiency of supply. Streamflows have held up well until this month; they are now at about the same level as in 1934, but above the low levels of 1931.

Oklahoma: Stream flow conditions are somewhat better than in 1934. Ground water is about a foot lower than in 1934, due to a lack of replenishment since that year. There has been no shortage of water supply.

South Dakota: Stream flows are lower than in 1934, and acute shortages are being experienced where water supply is dependent upon surface flow. Deep wells are holding up well.

Tennessee: Drought conditions were at no time serious, and by the end of July stream flows were back to normal.

Texas: Ground water supplies are higher than in 1934, although somewhat lower than in 1935.

West Virigina: Although some streams are below what they were at the same date in 1934, all are well above the 1930 minima. There has been no shortage in water supply.

Wyoming: There has been very little rain since early spring, and water supply shortages are occurring throughout the state. Stream flows are about the same as in 1934.

Detroit Incinerators To Be Built by County

Because Wayne County is financially better able to issue bonds to build garbage incinerators for Detroit, the city next month will vote on giving permission to the county to sponsor the project. The $1,460,000 for the four proposed plants is to come from PWA, 45 per cent grant and the remainder revenue bonds. The plants would have capacities of 450, 350, 350 and 250 tons, respectively.

Preliminaries Begun On Natchez Trace Parkway

The Mississippi state highway commission will begin acquisition of rights-of-way along the Natchez Trace Parkway with a $200,000 fund set aside in the recent session of the legislature for that purpose. Counties through which the route passes are required to pay 50 per cent of the cost of the right-of-way, purchase of which is all the state and counties are required to do on the project. The federal government will expend $10,300,000 on the highway within the next three years. At present $1,300,000 of WPA money is available which must be spent before July, 1937.

The parkway will consist of a 22-ft. concrete highway along the route of the old Natchez trail.

Washington Highlights

By Paul Wooton

Col. Julian L. Schley has resigned as Governor of the Panama Canal and will be succeeded by Col. Clarence S. Ridley, of the Corps of Engineers. Col. Schley tendered his resignation two months in advance of the expiration of his four year term so as to take advantage of his accumulated leave. At the expiration of his leave, Col. Schley will be assigned to the command of the engineer school at Fort Belvoir, Va.

An allocation of $11,981,964 of WPA money for the preparation of plans for flood control projects in Ohio, Pennsylvania, New York, Massachusetts, Connecticut and West Virginia was announced Aug. 25. The money may also be used for minor channel improvements where local interests will furnish the necessary rights-of-way. Levee work on the Susquehanna River will also be financed out of this allocation. In addition $114,827 was allotted to the WPA for reconstructing flood damaged bridges in Pennsylvania and Connecticut.

The chief of engineers has advised the Governor of Louisiana that he looks with favor on the proposal of the Louisiana executive that the state give assurances that flowage rights in the Louisiana floodways will be furnished at reasonable prices so that work could begin without waiting for options from individual land holders. Gen. Markham takes the position, however, that the assurances must be satisfactory to him and that they must be supplemented by the actual furnishing of levee rights-of-way.

Appraisals of the lands in the three Louisiana floodways, which it is proposed to use in carrying out the revised flood control program, will begin in the near future. The work will be under the immediate direction of O. M. Page, senior agricultural engineer attached to the Bureau of Agricultural Engineering. Mr. Page already has set up his headquarters at Vicksburg. The War Department is transferring $175,000 to the Bureau of Agricultural Engineering for the expense of the survey. It is expected that a year will be required to complete the work. Additional funds will be transferred when a more accurate estimate of requirements will be possible.

SOCIETY CALENDAR

CANADIAN GOOD ROADS ASSOCIATION, annual meeting, Charlottetown, P.E.I., September 1-3.

MONTANA BITUMINOUS ROAD CONFERENCE, sponsored by Montana Highway Dept., second annual conference, Glacier National Park, Sept. 8-10.

THIRD WORLD POWER CONFERENCE, Washington, D. C. Sept. 7-12.

PUBLIC WORKS CONGRESS, joint meeting, AMERICAN SOCIETY OF MUNICIPAL ENGINEERS AND INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Toronto, Ont., September 28-30.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, Royal York Hotel, Toronto, Oct. 1-2, 1936.

INTERNATIONAL CONFERENCE ON STEEL CONSTRUCTION, Berlin, Germany, Oct. 2-7.

NATIONAL SAFETY CONGRESS, annual meeting, Atlantic City, N. J., Oct. 5-9.

INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING, second congress, Berlin, Germany, Oct. 11.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, annual convention, Washington, D. C., Oct. 12-13.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Pittsburgh, Pa., Oct. 13-17.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Knoxville, Tenn., Oct. 19-21.

AMERICAN WELDING SOCIETY, annual meeting, Cleveland, Ohio, Oct. 19-23.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, New Orleans, La., Oct. 20-23.

AMERICAN WATER WORKS ASSOCIATION, ROCKY MOUNTAIN SECTION, Denver, Colo., Sept. 21-23.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, New York, N. Y., Sept. 22-25.

AMERICAN WATER WORKS ASSOCIATION, WISCONSIN SECTION, Waukesha, Wis., Oct. 6-7.

AMERICAN WATER WORKS ASSOCIATION, SOUTHWEST SECTION, section meeting, Fort Smith, Ark., Oct. 12-13.

AMERICAN WATER WORKS ASSOCIATION, NEW YORK SECTION, fall meeting, Saratoga Springs, N. Y., Oct. 15-16, 1936

AMERICAN WATER WORKS ASSOCIATION, NEW JERSEY SECTION; NEW JERSEY WATER WORKS ASSOCIATION; and the SOUTH JERSEY ASSOCIATION OF WATER SUPERINTENDENTS; joint meeting, Atlantic City, N. J., Oct. 23-24.

AMERICAN WATER WORKS ASSOCIATION, MISSOURI VALLEY SECTION, Kansas City, Mo., Oct. 26-28.

AMERICAN WATER WORKS ASSOCIATION, NORTH CAROLINA SECTION, Charlotte, N. C., Oct. 26-28.

AMERICAN WATER WORKS ASSOCIATION, VIRGINIA SECTION, Charlottesville, Va., Oct. 29-31.

EXAMINATIONS for registration as Engineers, Land Surveyors and Architects will be held as follows:

NEW MEXICO, examination for professional engineers and land surveyors, Santa Fe, Sept. 12.

Brief News

CHARLES MILLS DAM, the first of the fourteen reservoirs included in the $40,000,000 flood control project in the Muskingum Valley, has been completed. The dam is located on the Black Fork of the Mohican River. Clearing of the reservoir area for a 1,350-acre lake is expected to be completed in the spring.

THE LAST SECTION, 58 miles in length, of the second east-west railway line through Czechoslavakia has just been completed. The new section, between Cervena Skala and Margecany, has been under construction for the past five years and was completed at a cost of about $10,000,000. The line runs through mountainous country at an average elevation of 2,000 ft.; it involved the construction of nine tunnels and several viaducts.

HYDRAULIC MODEL STUDIES for the Keystone Dam of the Central Nebraska Public Power & Irrigation District will be carried on in the laboratories of the Case School of Applied Science in Cleveland, Ohio. The model will be on a scale of 1 to 40 and will include a spillway of the morning glory type with a gate controlled crest, a control tower for release of irrigation water and twin tunnels leading from these units to a common stilling basin. Additional tests will be made on auxiliary structures. The work will be under the direction of Professor George Barnes.

Personals

ROBERT A. HURLEY, director of the WPA program at Bridgeport, Conn., has been appointed works progress administrator for the state of Connecticut.

LIEUT. COL. EARL A. GESLER has been appointed district engineer for the Rock Island district of the U. S. Engineers. Col. Gesler has been acting district engineer for the past few months.

T. T. KNAPPEN, who has been chief of the engineering division on the Muskingum flood control project, has been appointed chief of the flood control section for the North Atlantic Division of the U. S. Engineers.

STANLEY T. BARKER, who has been a designing and resident engineer for Weston & Sampson, consulting engineers, of Boston, has been appointed an assistant sanitary engineer for the New York State Department of Health.

V. P. JENSEN, assistant professor of mechanics at Iowa State College, has been named to the position of analyst with the U. S. Bureau of Roads and other cooperating bodies that have started a structural research project on highway pavement slabs. Headquarters of the project will be at the University of Illinois.

Obituary

CLARENCE A. KUTCHER, city building inspector of Iowa City, Iowa, died on August 14 in that city at the age of 48.

HARRY MCGRATH, a member of the contracting firm of Fellows & McGrath, died on August 14 in Syracuse, N. Y., at the age of 48.

ALEXANDER S. POW, SR., civil and mining consulting engineer of Birmingham, Ala., died on August 10 at the age of 58.

LEONARD A. MCNEIL, formerly city engineer of Hartford, Conn., and for many years a civil engineer in Florence, Wis., died recently at Wheaton, Ill., aged 88.

JOHN B. DAVIS, 84, who was a consulting engineer for railroads throughout the country for the past 35 years, died on August 15 in Lakewood, Ohio.

JAMES H. POLHEMUS, chief engineer and general manager of the Port of Portland, Ore., has resigned to accept a position as executive vice-president of the Portland Electric Power Co.

ALEXANDER DUNCAN MCDOUGALL, a general contractor of Portland, Ore., who was active in railway construction, died in Portland on July 23 at the age of 87.

EDWIN SCHENCK, JR., who, prior to his retirement 10 years ago, was a member of the engineering department of the Pennsylvania Railroad, died in Philadelphia on August 22, aged 65.

JOHN F. KERWIN, a New York contractor, died in New Brunswick, N. J., on August 23, aged 66. Mr. Kerwin was active in road construction in Manhattan and Long Island.

JOHN H. LUENING, 44, a consulting engineer of Louisville, Ky., died in that city on August 21. Before going into private practice two years ago, Mr. Luening was associated with the Girdler Corp., as a consulting engineer.

PAUL TAYLOR, an engineer connected with the Bureau of Public Roads at Ogden, Utah, was killed on August 21 in Stanley, Idaho, when the automobile in which he was riding with other employees of the Bureau plunged over an embankment.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards total $49,055,000 for this week, only slightly under last week and more than ten per cent higher than the average week to date. This total is made up of private, $10,879,000; public, $38,176,000, of which federal work totals $12,104,000 and state and municipal, $26,072,000. The corresponding values for a year ago are: total, $26,941,000; private, $5,595,000; public, $21,346,000; Federal, $5,933,000 and state and municipal, $15,413,000.

Sewerage, industrial buildings, bridges and commercial buildings gained volume over last week. The classified values are: industrial buildings, $7,639,000; commercial buildings, $2,381,000; public buildings, $13,029,000; highways, $11,014,000; bridges, $5,719,000; sewerage, $2,215,000; waterworks, $654,000; earthwork, drainage, $3,731,000; unclassified, $2,673,000.

The larger awards for the week include: reconditioning steel mills, Follansbee Bros. Co., Toledo, Ohio, and Follensbee, W. Va., $5,000,000; superstructure, Hill Creek Housing project, Philadelphia, Pa., $1,521,000; post office, Cincinnati, Ohio, $2,877,000; highways, by Missouri, $541,000; by California, $510,000; by Michigan, $580,000; by New York, $1,094,000; by South Carolina, $2,366,000; bridges, by Mississippi, $1,723,000; by Texas, $504,000; esplanade and landscaping, Grand Central Parkway extension, Triborough Bridge Authority, New York, $961,000; viaduct from Pike Street to Celestial Street, Cincinnati, Ohio, $624,000; electrical equipment for Wards Island Sewage Treatment Works, Contract EM2, New York, $1,647,000; deepening, widening and straightening Tioughnioga River and Dudley Creek, Chocton River at Oxford and Painted Post, Canisteo River for flood control, relief labor, New York, $958,000; electrical installation for Midtown Hudson Tunnel, Contract NHT-15, New York, $948,000.

New capital for the week includes a transfer from federal to private investment financing through sale by RFC of PWA bonds, totaling $4,084,000, making total state and municipal bond purchases for the week $13,940,000. Corporate security sales total $5,665,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Average August 1935	Prev. 4 Weeks	Week Aug. 27 1936
Federal Government	$12,611	$12,964	$12,104
State and Municipal	12,396	21,999	26,072
Total public	$25,007	$34,963	$38,176
Total private	6,439	9,839	10,879
Week's total	$31,446	$44,802	$49,055
Cumulative to date:			
1935..$901,373,000	1936..$1,541,632,000		

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

1936	Week Aug. 27	Cumulative
State and municipal..	$13,944†	$340,400
PWA non-federal	—4,084†	55,205
RFC loans	....	12,479
Corporate issues	5,665	157,381
PWA loans, Private...	....	—1,665*
Total Non-Federal..	$15,525	$563,800
Federal	.....	691,237
Total new capital...	$15,525	$1,255,037
Cumulative to date:		
1935..$1,497,792,000	1936..$1,255,037,000	

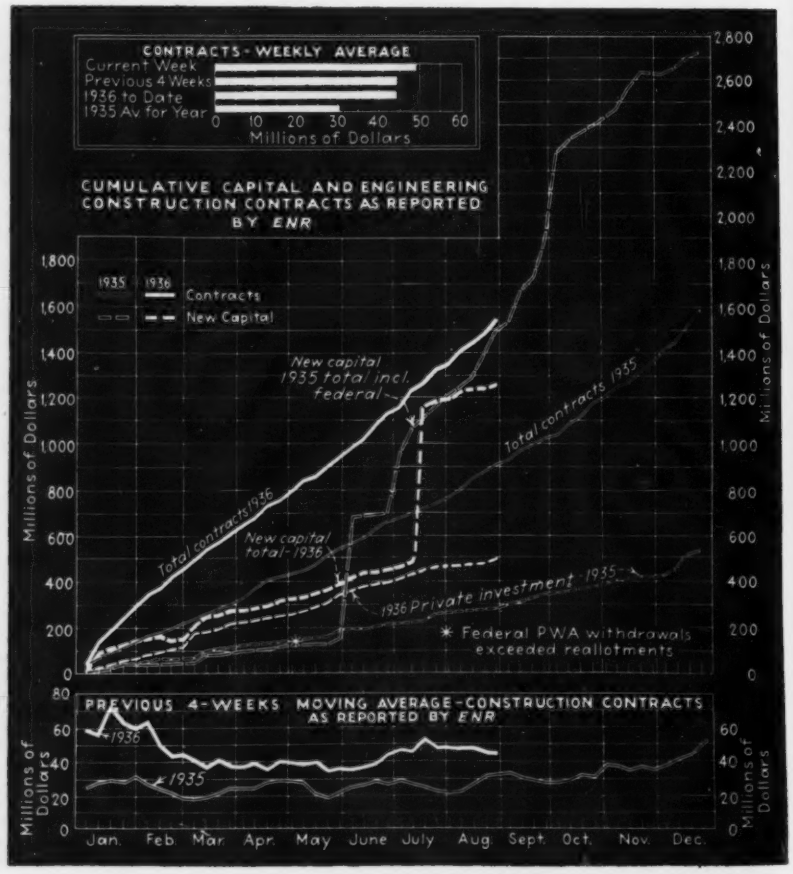
†Includes transfer from federal to private investment financing through sale by RFC of PWA bonds.

*Bond sales in this classification exceed reallotments during current year.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA appropriations for construction projects.

INDEX NUMBER

ENR Cost	1913 =100	1926 =100	ENR Volume	1913 =100	1926 =100
Aug., 1936	**208.10**	**100.03**	**July, 1936**	**188**	**82**
July, 1936	204.40	98.25	June, 1936	194	85
Aug., 1935	195.10	93.82	July, 1935	96	42
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total-1936
1936 Private investment
1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
1935
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Millions of Dollars